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Toxaway Dam Failure

ANALYSES of dam failures generally reveal faulty foundations as the primary cause of trouble. Such appears to be the case with the Lake Toxaway dam in North Carolina, which went out Aug. 13. Mr. Willis, in his article in the news section of this issue, attributes the failure to a stream of water flowing through fissured rock at the base of the structure. He also states specifically that a small stream or seepage spring at the foot of the dam had been running ever since the reservoir was created, and that this spring began to increase in volume and, what is most significant, in turbidity, more than a week before the failure occurred. With this subsurface channel operating under a head higher than normal, due to remarkably heavy precipitation, which raised the reservoir level, it was only a question of time when enough of the earthfill would be carried away to cause a cave-in and a subsequent breach through the main body of the structure. Mr. Willis does not give many details regarding the foundation except to say that a transverse channel had been blasted across the dam site in solid rock. Was this rock "solid"? Were borings made to reveal its true character? These are the questions which immediately suggest themselves to the engineer. If fissures in the foundation rock had been disclosed by subsurface exploration with drills before the dam was built they might have been sealed effectively by high-pressure grouting, a method frequently resorted to in current practice.

Making Grade Crossings Safer

NOBODY is going about these days urging the perpetuation of the railroad grade crossing. All agree that it is dangerous and a thing to be eliminated as rapidly as possible, but reasonable people realize that this cannot be accomplished in a twinkling. The next best thing to do is to minimize the dangers of the level crossing, and in this respect some of the railroads are going beyond the legal requirements. Considerable publicity has been given to the campaign of the Long Island Railroad, where automobilists have been wont to race with trains for the crossings. Now the Baltimore & Ohio announces that it has instructed its local officials to approach each grade crossing on foot from the public highways, as well as from the right-of-way, and note whether or not pedestrians, drivers of vehicles and locomotive enginemen have an unobstructed vision. The railroad promises to follow up these visits by doing all it can to correct bad conditions—trimming trees, removing fences and small buildings and, possibly, altering the location of side tracks. If this is done carefully over the entire system it will mean much, but at the same time the public should remember its own responsibility in the matter. Probably 90 per cent of all grade-crossing accidents are due to failure to heed warning signs, bells, gates or flagmen. While it is not fitting that the penalty for heedlessness on the part of a chauffeur should be the death of all the occupants of an auto, neither is it fair to denounce the railroad as the sole cause of the disaster.

New England Waterworks Convention

AFTER several years of journeying beyond the limits suggested by its name, the annual convention of the New England Waterworks Association this year will have a real "Down East" setting. In the last half dozen years four of the meetings have been in alien territory—New York, Philadelphia, Washington and Rochester. Next month's session (Sept. 13, 14 and 15) at Portland, Me., therefore, will carry with it the spirit of "old home week"—a welcoming of New England's sons back to their native heath. To this welcome there should be a hearty response. Past meetings of the society have been well worth attending, for they have blended happily opportunities for work and play. Portland, as a host to the convention, is not to be outdone by other municipalities, for she has placed her new City Hall at the disposal of the delegates for both meetings and exhibits of waterworks equipment and appliances. Five sessions of the convention will be devoted to papers and discussions, and the committee is working hard to make the program attractive to superintendents. In former years this journal has endeavored to convince city officials that they will be well repaid by sending their waterworks superintendents and engineers to meetings of this sort and paying their expenses. It repeats this plea now, for the New England convention offers a unique opportunity, each year, for learning of the newer and better things in waterworks practice.

Motor Traffic Increase

A PERUSAL of highway construction literature for the last few years discloses the oft-recurring phrase, "increase in the use of motor vehicles." No road-builder needs to be reminded that this increase is an actual fact, and one which has a very decided bearing upon his own work. Stated in general terms, however, the real significance of the motor vehicle's growth in popularity is lost. What it actually amounts to is set forth specifically in a recent bulletin issued by the Division of Road Economics of the U. S. Office of Public Roads and Rural Engineering. The figures are truly startling. During the last ten years the state registration of motor cars, including commercial vehicles, has increased 5000 per cent, or from about 48,000 in 1906 to 2,445,664 in 1915. Highway engineers will be impressed by these figures, not merely because they indicate an astonishing development of the motor vehicle as a factor in transportation, but because they represent a rapidly growing source of revenue, in registration fees, for road-building and maintenance purposes. In 1906 less than three-tenths of 1 per cent of the total rural road and bridge expenditures in the United States was derived from motor vehicle revenues, while in 1915 nearly 7 per cent was secured from this source. The total amount collected by the various states in 1905 amounted to only $62,500. In 1915, however, the total gross revenue from registration of motor vehicles and the licensing of operators was swelled to the sum of $18,245,713. The chief interest of highway engineers in these statistics is in this fact—that of the total revenue collected during 1915 practically 90 per cent was applicable to road work, and of this amount slightly more than 70 per cent was placed more or less directly under the control and supervision of state highway departments.

Highway Engineers Must Write

THREE BENEFITS are bound to result from a general order which Austin B. Fletcher, state highway engineer of California, issued early this year to all of his division engineers. The order called upon each of them for a weekly story of about 1000 words on some phase of his work. And by "story" is meant not a cut-and-dried statement of progress, but rather material, in the form of description or narrative, bringing out the real significance of the work each engineer is doing—particularly how it will benefit the public which is paying the bills. The articles are wanted, primarily, for the California commission's highway bulletin and for distribution to the press. When the scheme was first put into effect it was found that the division engineers dealt too largely in technicalities. They either did not appraise their audience correctly or were unable to address this audience in words which would convey any real message. To correct this tendency a number of useful suggestions for stories were sent out from the main office. Here are a few samples: Mileage saved by completing new highway section; elimination of a steep, well-known grade, dangerous curve or railroad crossing; description of a local celebration in honor of a finished highway; the finding of Indian relics or anything carrying a story of the early history of California; the making accessible of strange or picturesque new country or points of historic interest; voluntary praise of the state highway system by distinguished visitors. The first and obvious effect of the weekly-story order is that it will teach the division engineers to write. In the second place, the very practice of interpreting their activities will prevent them from falling into a rut of mere technical routine. The third and most important result will be the education of California's public to the work that its highway commission is doing.

A Hint for Timid Speakers

AN assistant engineer in one of the bureaus of a large public-works department was invited recently to deliver an address before the members of a college engineering society. The young engineer had taken a prominent part in the general planning and design of a great municipal project, but he had no experience in public speaking and was thoroughly frightened at the prospect of standing up before an audience and describing work with which he was thoroughly familiar. He was on the point of declining the invitation to speak, but decided to seek the advice of the chief engineer of his department. "There is no option about this matter at all," said the latter; "you must deliver this address. Before I made my first speech I was as uncertain of myself as you are now, but this is the system I adopted: I selected a number of lantern slides showing various features of the work I had to talk about. I arranged them in logical order, turned them over to the stereopticon operator and then requested that all lights be put out. In the darkness I immediately felt at ease, and when the first view was shown upon the screen I found no difficulty in talking. I then signaled for the next view and continued in this way to the end, making a fairly creditable showing. I decided at the outset not to depend upon any written paper." The assistant engineer followed these tactics in his initial address and came through with flying colors. The mere darkening of the lecture room before he began talking seemed to give him confidence in himself. To-day he finds no need of resorting to these methods and looks upon the delivery of an address about his work as an ordinary event. Engineers who are handicapped by diffidence in speaking in public may find this experience of value to them.

Splitting Hairs

MENTION was made by W. H. Rayner in his letter in last week's issue, page 239, of the wasting of labor in computing results to five and six figures when there are no more than three significant figures in either factor. Experienced engineers are not likely to be guilty of this, but the practice is surprisingly common among the younger generation. A rather hard-headed mathematics instructor in the engineering department of one prominent university used to insist that the entrance requirements for a technical course should include a stiff examination in arithmetic. Certainly there is something wrong in the mathematical grounding and balance of the young man who, in making a survey of buildings by the intersecting-arc method, reads his distances to hundredths of a foot, but gets his arc intersections so flat that they will not plot; or who, in taking cross-sections of soft ground, uses a target on his level rod, and then computes his volumes to tenths by the average-end method from stations 100 ft. apart, but fails to divide by 27 to get cubic yards instead of cubic feet; or who accepts obviously absurd results of any sort because the figures seem to show such results. Hasty inspection will usually tell whether a figure is reasonable or not, and that should always be made, whether the figure was obtained mentally, by slide rule or with seven-place logarithms. Beyond that, however, the young engineer should have constantly in mind the purpose of his work, the degree of accuracy desired and the degree obtainable with the methods employed. He should know, for instance, as Mr. Rayner has suggested, that you cannot multiply three significant figures by three significant figures and get six correct figures. Then he should be thoroughly conversant with some of the simple shorthand methods of arithmetic—synthetic multiplication and division, the use of reciprocal factors, cancellation, approximations. At the same time he must know where to draw the line in approximations, so that he will not throw out all of the significant figures and miss his mark entirely. It is bad to be unable to make a precise calculation when precision is demanded. It is almost equally bad to be unable to produce any sort of reliable result when there is no time for hair-splitting accuracy.

Is State Insurance Accident Prevention?

A LARGE contractor, referring to some of his work in a state which has advanced liability laws and state insurance, recently remarked that the state system was perfect. He no longer worried about accidents, damage suits and troubles with insurance rates. The very next day the chief engineer of construction of a railroad operating in an adjoining state having similar compensation laws added this significant statement: "The contractors don't seem to care any more whether their men get hurt or not. They pay so much to the state, and if a man gets careless and falls off a trestle, the state takes care of him. Why should the contractor worry?"

Why, indeed? With private insurance an inspector is on the job after every serious accident and at regular intervals when there are no accidents. If accidents increase unwarrantably the contractor's rate goes up. As a result a heavy premium is put on unsafe construction. Foremen and men are instructed and cautioned. The careless and unfit are discharged. Safeguards are maintained and extended. Dangerous practices are curbed.

State insurance administrators should look to these matters if the whole experiment of public liability, met through taxation of the protected industries, is not to prove a colossal failure. Further neglect of them cannot but raise the cost of compensation and the tax rate charged for state protection. The advantages of state insurance over the old system of common law suits are in a fair way to be lost through shipwreck on this one obstruction.

The remedy is at hand—the safe channel has already been marked out by the private companies. Accident prevention through inspection and differential rates based on the accident records of the insured mark the way to the goal of reduction in public cost of accident compensation and better protection for the working man.

War's Light on Technical Education

TO NEUTRALS the European War has been far more than a succession of campaigns or a gigantic interplay of upset economic forces. It has been a panorama of nations stripped of artificiality. Under the stress of conflict characteristics have stood forth as never before. National virtues and weaknesses have been emphasized. Hidden motives have been revealed.

It is not surprising that educational systems, necessarily responsible for national traits, have been searched by the war's light. That, if anything, could show up their excellences and their weaknesses.

In April of this year, Dr. John Dewey, professor of philosophy in Columbia University, discussed in the *New Republic* the German and British educational ideals as revealed by the war. More recently Earl Cromer in a debate in the British House of Lords expressed views identical with those of Dr. Dewey. Their analyses should prove especially interesting to engineers, for their conclusions involve the very problems of technical education which are most debated with reference to technical education.

Dr. Dewey and Earl Cromer conclude that both English and German education have been at fault, though in exactly opposite directions. Germany has overemphasized scientific education. England has given too little attention to science and has laid too great stress on liberal and humanistic subjects. Both observers plead for a serious consideration of the lessons which the war has taught, to the end that there may be a proper balancing of liberal and scientific studies.

So much has been written upon the military organization of both Germany and England in this war that it seems unnecessary to discuss them at length in order to point out the justification for the views expressed by Dr. Dewey and Earl Cromer. The machinelike precision of the whole German military organization, backed by an industrial plan that meshed perfectly with the strictly military movements, has been the marvel of the world. On the other hand, there is no need to point out the miserable failure of Germany to judge correctly other peoples, whether belligerent or neutral. Her diplomacy has been anything but diplomatic.

England, on the other hand, while not miscalculating the psychological and diplomatic phases of the conflict and of the issues it has raised, was unprepared industrially. Its unpreparedness, too, was not merely in the failure of the military authorities to appraise, and prepare to use, the industrial resources of the empire, but in the entire lack of a scientific industrial organization able to cope quickly with the great problems which the war imposed. In the debate above referred to, for example, Viscount Haldane, one of the participants, pointed out that at the outbreak of the war there were only 1500 trained chemists in England. He intimated that the same lack of experts existed through the whole gamut of British industries.

The application of these observations to engineering education is obvious. Our courses should be so shaped that humanizing studies will go hand in hand with the technical. We want not merely scientific machines, but engineers with broad human sympathies, who will bear their part well as citizens. At the same time their technical attainments must be above question. In other words, a combination of the scientific spirit of Germany with the cultural qualities that distinguish the graduates of the English universities is what we seek. Not easy of accomplishment, it is true, but necessary if we are to avoid the defects which the critics here cited have found in the educational systems of the two leading warring powers.

Standardize Structural Details

ONE of the most prolific sources of disagreement among structural engineers is found in the field of those ever-recurring details of connections for which each experienced detailer is apt to develop strong personal preferences. While proper details and adequate attention to the many small but vital matters, such as lacing, tie plates, jaw plates, etc., are highly essential, it is doubtful whether the small changes about which strenuous arguments often occur are sufficiently important to occupy so much of the engineers' time. Cannot the stormy sessions or many long letters in which the relative advantages and disadvantages of a given detail are argued at length be avoided in the future, and at the same time the true importance of these details recognized, by a serious attempt at standardization which will harmonize the practice of all big fabricating companies and designing engineers throughout the country?

Take for example the number and distribution of rivets used in connecting angles to gusset plates. Should not the general principle be adopted that the connection should be made good enough to carry the full working stress in the main section, and in that way, based upon standard specifications and thickness of plates, fix once for all the number and distribution of the rivets? It is assumed that the question whether clip or lug angles should be used would be one of the first to be settled —based upon results of tests such as those made by Professor Batho (see the Engineering Record of Oct. 23, 1915, page 512).

Only a committee of broad-gage men with national reputations would be competent to settle such details and insure their general adoption, and it is proposed that a committee of members of the American Society of Civil Engineers, such as suggested by this journal in the issue of June 24, 1916, page 821, should, after drawing up standard specifications for steel buildings, proceed to consider the standardization of structural details. Ample field for the ingenuity of the detailer would still remain in the multitude of special problems which arise so often in structural work, yet essential principles and, so far as practicable, universally standard details should be definitely fixed. It is believed that a vast amount of useless and wearying minutiæ might thus be avoided.

Range-Finding as an Engineering Problem

THE war correspondents speak so glibly of range-finding at the front that the uninitiated might suppose that it involved no particular difficulties. Engineers who are familiar with problems of triangulation, however, know better, and from experience are in a position to sympathize with their military and naval brethren.

Fundamentally, range-finding is nothing more than a problem in triangulation, where, from a measured base line, the distance of a given object is sought. Ordinarily the engineer reaches his results by the use of an exact base with accurate transit observations made at each end, thus giving two angles and the included side of the unknown triangle. Sometimes, for simplicity, he may make one of these angles a right angle in laying out his base. If the distance to be measured is long, he may have to allow for the curvature of the earth, and if his base line and the object are not on the same level he may have to figure the difference of elevation.

Consider now the difficulties which the artillery officer, military or naval, has to face. With leisure and a front not exposed to fire he may proceed comfortably, like his confrère in civil life, using the same instruments and methods; but this is altogether an abnormal situation. On land the object of which the distance is sought is usually out of sight from the gun. Its distance and elevation must therefore be found from a point which may be anywhere from a few hundred yards to a mile or more from the battery, and the range, azimuth of laying the guns and elevation must be computed for the battery from readings taken at the post of observation. In field artillery work the data must be obtained and reduced for the gun pointer inside of a very few minutes. There is generally neither time nor opportunity to triangulate by ordinary methods, even if the apparatus were at hand.

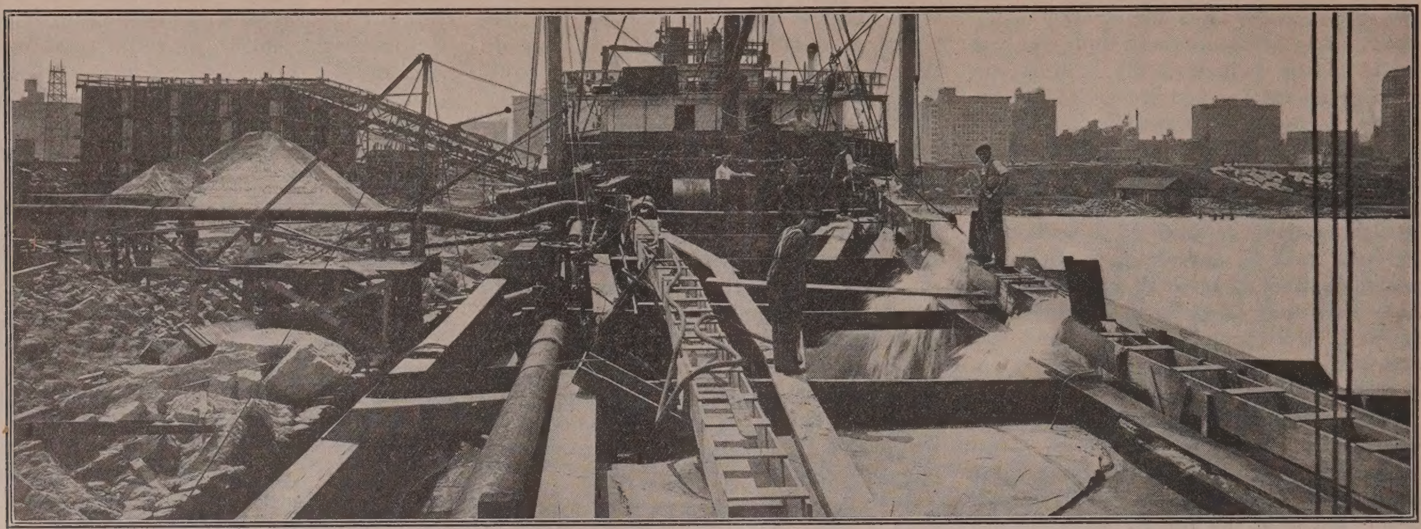
The military engineer, therefore, is driven to range-finding with a base of such length as he can carry with him in an instrument capable of being carried by a mounted man, with all the contingencies of accident, while yet remaining in working order and giving a good degree of precision. Ranges must be found up to five miles from an instrument, constituting the base line, no more than three or four feet long. This is practically a tube with a pentagonal prism at each end, bending the rays from the object at right angles. The rays are then united by two objectives into the field of a common eyepiece. One of the prisms is always fixed and the other either capable of a slight and exactly measurable rotation or, more usually, supplied with equivalent means of shifting its line of sight, so that the images as observed from each end of the base line may be brought into coincidence. In most instances this adjustment is made by sliding a prism of small angle along one side of the tube, thereby deflecting the rays from the corresponding end of the base line by a measurable amount, and, the base line being fixed, the device can, by a suitably graduated scale, be made direct-reading, so that the distance of the object, once the images are in coincidence, can immediately be read off.

The difficulties of the artillery range-finding on land, however, are as nothing to those encountered on the sea. Here the actual fighting ranges extend to 10 or 12 miles, at which distance ships may easily be sunk by gun fire. The range-finder used for the purpose is ordinarily similar to that just described, but with a tube 10 or 15 feet in length, giving a correspondingly longer base. At 10 miles, however, even the longer distance subtends scarcely one minute of arc, so that the precision of measurement necessary is not easy to obtain, particularly as the instrument is often mounted on the top of a turret or in other positions where the tremendous concussion of the big guns subjects it to shocks which require the most robust construction.

The most serious difficulty is found in changes of atmospheric refraction, the phenomenon which, in its commonest form, is known as mirage. Even at the distance of a very few miles mirage may falsify elevations of objects seen. Likewise lateral deviations may appear, and the images writhe and wobble in the field to an extent that must be seen to be appreciated. Under these conditions even the best range-finder may give misleading information.

The great desideratum in naval range-finding is in some way to obtain stability with a longer base, thus minimizing the various difficulties of the situation. For a long time our Navy used a depression range-finder. This used the height of the crows-nest from the water as a base and measured the depression of the enemy's water line. This gave the increase in base, but magnified all the difficulties that arose from mirage and is now practically abandoned.

All kinds of ingenious schemes have been planned for using the length of the ship or even the distance between ship and ship in a squadron as a working base, but none of them has yet worked out in a satisfactory manner. The problem of improvement is one to stagger the ingenuity of the engineer, and if the notes can induce anyone to whet his wits successfully on practical improvements it will do good service to the military art.



HYDRAULIC SAND BOAT DISCHARGING ITS CARGO WITH ONE PUMP WHILE SECOND PUMP FEEDS IN LAKE WATER. EACH BIN HAS SEPARATE SUCTION PIPE, WATER BEING FED FROM OVERHEAD TROUGH

Sand Sluiced Around Field Museum Columns, Chicago, Holds Them for More Fill by Conveyors

Combined Tripper and Shuttle Conveyor on Transfer Belt Carries Dry Sand from One Boat 1350 Feet While Other Boat Is Successfully Unloaded by Pumping

FILL around the Field Museum foundation columns in Grant Park, Chicago's front yard, amounts to 180,000 cu. yd., and with the attendant fill outside will reach a total of more than 600,000 cu. yd., a quantity warranting a large initial expenditure for plant. The salient features consist of an elaborate belt-conveyor system for transporting the sand from a boat a maximum of 1350 ft. to the 400 x 750-ft. building, a special shuttle tripper in a transverse conveyor and a second hydraulic system which is operated by pumps located on one of the sand boats.

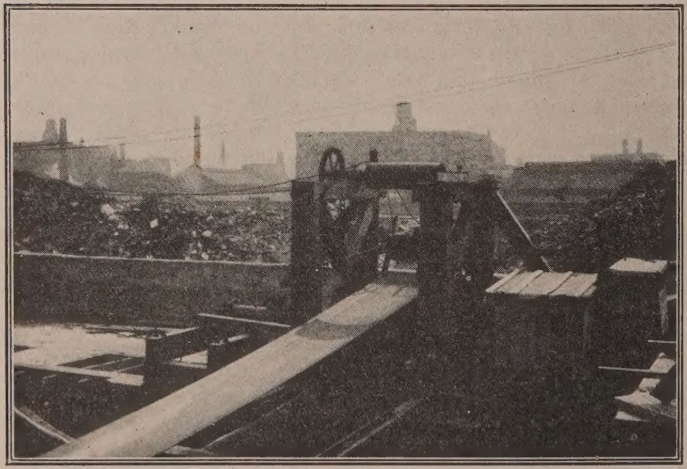
The Field Museum is said to be the largest marble building in the world, and is built on made ground opposite the Twelfth Street station of the Illinois Central Railroad. Concrete columns with their tops at El. 33 above city datum, resting on nests of piles cut off at El. — 1, will support the building proper. Filling at the site by the Illinois Tunnel Company has been going on for several years, and there has been miscellaneous dumping from the nearby loop district, so that when the contractor began operations two years ago the elevation was at + 9, whereas the basement-floor level is to be at + 33 and the main floor at El. + 50. Suggestions have been made that this valuable sub-basement space be utilized for an aquarium or for a public garage, of which Chicago is now so much in need. The enormous expense of completing this work and designing a floor slab and girder system having bays 42 ft. by 9 to 20 ft. on a side over the area precluded any serious consideration of these plans.

TRACK IMPOSSIBLE

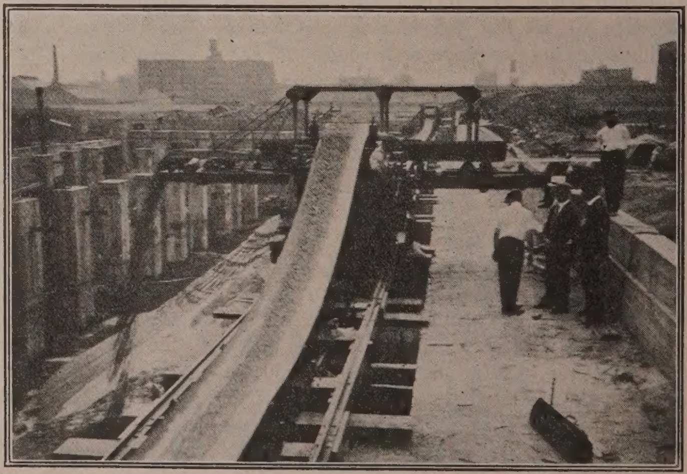
The space is now being filled with sand from boats and the basement floor will be laid directly on the fill, all other work being practically suspended until this work has been completed late this fall. In the choice of method of filling, tracks were out of the question, as no room was available to make turns, and as there was danger of shifting columns. The material already in place is soft fill and easily shifted.

To the north of the site about 700 ft. is an east-and-west dock to which the sand boats have access. A harbor only 8 to 12 ft. deep had to be dredged to give 19-ft. channels 90 ft. wide. Near the shore two bins of 900-yd. capacity each, with four compartments, were erected. The sand is pumped from the Barth, a boat specially rebuilt for this job with three bins, 28 x 21 x 13½ ft. deep, into the bins and the water drained off through vertical sluices on the side of each compartment. The other boat unloads upon a stock pile over a 100-ft. tunnel conveyor leading to the 30-in. main belt conveyor passing between the above bins. This conveyor runs south to the building, rising in the last 100 ft. as shown in one of the photographs to the level of the finished fill at the top of the present concrete work. Here it is discharged upon a 30-in. conveyor, 425 ft. long, continuing south across the full width of the building.

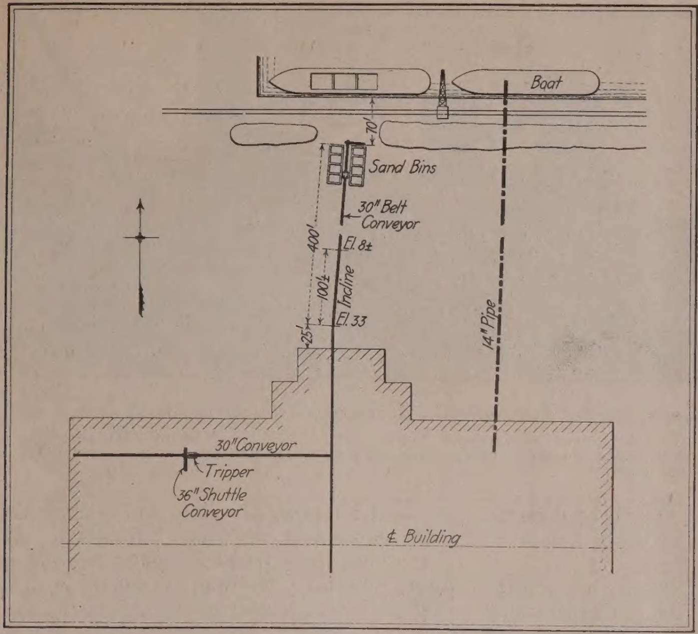
A tripper on this belt discharges upon a transfer conveyor running to the west wall. Both of these belts are mounted on the con-



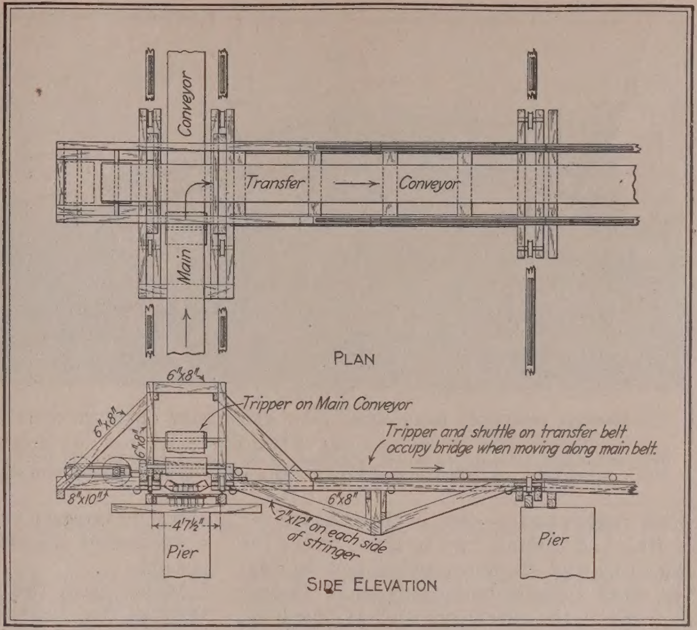
MOTOR RUNNING TRANSFER BELT DRIVES CRAB AND WINDING SPOOL



SHUTTLE CONVEYOR HAS 18-FOOT OVERHANG ON EITHER SIDE



RELATIVE UNLOADING POSITIONS OF THE TWO BOATS AND ARRANGEMENT OF THE BINS AND CONVEYOR SYSTEM


Conveyor
Transfer
Conveyor
Main
PLAN
6"x8"
6"x8"
6"x8"
Tripper on Main Conveyor
Tripper and shuttle on transfer belt occupy bridge when moving along main belt.
8"x10"
6"x8"
4'7½"
2"x12" on each side of stringer
Pier
Pier
SIDE ELEVATION

TRUSSED BRIDGE FOR THE SHUTTLE AND THE TWO TRIPPERS CARRIES THEM TO THEIR NEW POSITION ON THE PIERS

crete columns, but the transfer line starts at the north wall and is moved over its own fill toward the south. The successive stations will be 21 ft. apart, or in the center of the light bays and on the tops of the seven lines of columns and on the north and south walls.

SHUTTLE NEW FOR SAND

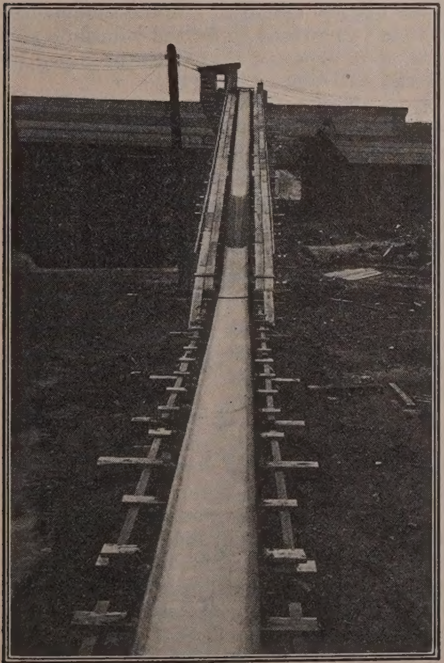
The tripper on the transfer belt has a 36-in. shuttle conveyor belt overhanging a maximum of 18 ft. on either side. It and other new machinery were made by the Weller Manufacturing Company. This is probably the first time this shuttle arrangement, which is used in making wide stock piles of coal or ore, has been used in making a sand fill. The 40-hp. motor for driving the transfer belt is located at the west end and is connected by a clutch and reducing gears to a winch for winding up the belt before moving the track on which the shuttle and tripper run. The winch is also for use in pulling over the sand the 14-ft. sections of track, which are mounted on plank sleds.

The shuttle mechanism and the tripper moving along the transfer belt are driven by the transfer belt itself.

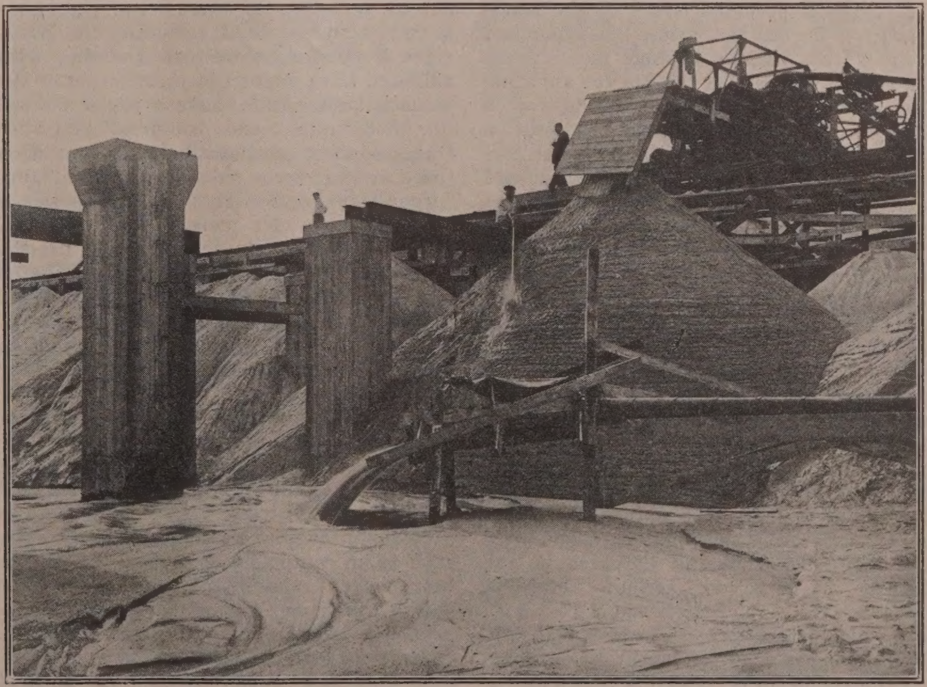
In moving the transfer conveyor to the next station the shuttle tripper is driven up close to the receiving end near the tripper on the main belt onto a trussed bridge with a span reaching to a track laid on the first line of piers to the west. Both trippers can then be moved south the required distance to the new position of the transfer belt.

Two boats bring the sand used for filling from the Michigan or Indiana shore, as little sand dredging is available in shallow water on the Illinois shore. The limit in depth for the suction is about 25 ft. The Hydro has two 500-yd. bins, and unloads by means of two derricks with 2-yd. clamshell buckets delivering into a small central hopper feeding a belt conveyor on a 72-ft. boom, which discharges the 1000-yd. load onto the stock pile in three to five hours. The stock pile provides leeway for both the boat and the conveyor system, the latter operating at about 250-yd. capacity per hour. This boat makes one trip to the Michigan shore daily, and requires from three to four hours to load. The aim is to do the loading in daylight if possible.

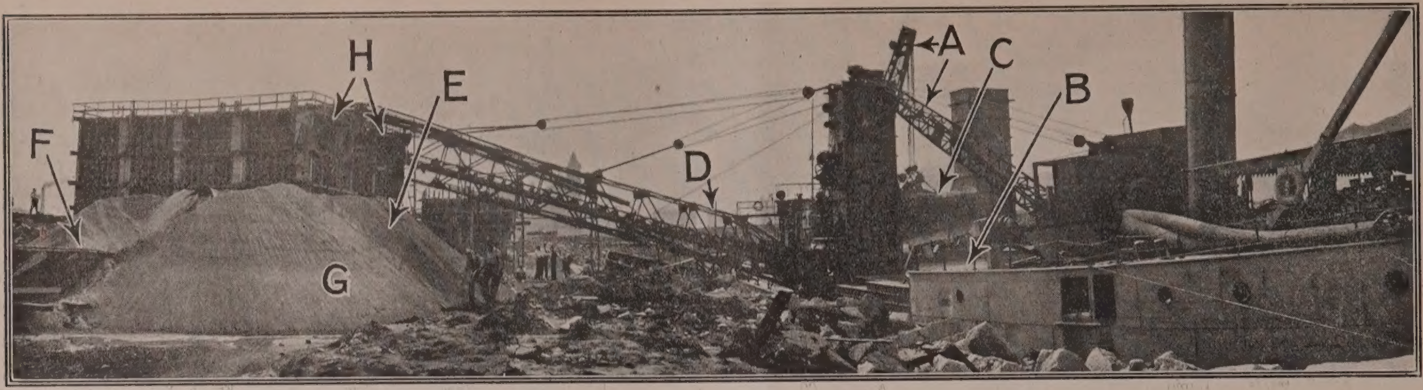
The Barth carries about 600 yd., and is equipped with two 12-in. special Erie centrifugal pumps, both of which are used to load. In unloading water must be pumped in by one of the pumps, as the 1000-ft. line of 14-in. spiral riveted pipe to the building carries about 80 per cent water and 20 per cent sand. This boat usually loads near Gary, Ind., and makes the round trip in



SAND FILLING BELT IS MOUNTED ON SLED SECTIONS FOR QUICK MOVEMENT



SAND FROM BELT CONVEYORS IS RUN IN ON TOP OF THAT PUMPED IN AROUND COLUMNS, WHICH SPREADS OUT EVENLY ON ABOUT A 15-DEGREE SLOPE



80-FOOT CONVEYOR DISCHARGES SAND FROM BOAT ONTO STOCK PILE, WHENCE FEEDER BELT FOR MAIN CONVEYOR LEADS TO BUILDING SITE

Revolving cranes (A) on each side of boat take sand from 500-yard bins (B) and deliver to conveyor hopper (C). Conveyor boom (D) reaches over stock pile (E), under which is tunnel (G). Short belt in this tunnel feeds on main conveyor (F), which runs between two sand bins to building site. Sand bins are filled hydraulically from other boat and feed onto same main conveyor.

about twelve hours—two to three hours for loading and coaling, two to three hours for unloading and six hours going and coming. The sand spreads out evenly on a 15-deg. slope from the discharge end of the pipe. At first the hydraulic fill was separated from the west portion by sand discharged under the main conveyor. It is intended to fill back under the depressed existing floor of the lecture hall hydraulically, as the sand will have to be carried horizontally about 150 ft. After running for a short time with the conveyors the spiral pipe was laid in a cut running under the main conveyor to the west side to fill in hydraulically around the bases of the columns so as to prevent their moving and thus let the work progress more rapidly. Marble for the structure has been on hand for two years, and it is imperative that the fill be done on a portion of the site at as early a date as possible.

Water from the sand drains off quickly through the cinder fill. An old breakwater runs from the north dock to the center of the building and then turns west. This was not removed, and is now found to make an excellent main underdrain for collecting the water from the cinders and carrying it back to the lake.

The filling is being done by J. R. Sensibar, sub-contractor to the Thompson-Starrett Company, general contractor. The conveyor system was designed by the Raymond W. Dull Company. Graham, Burnham & Company are the architects and have supervision over the construction for the trustees of the Field Museum fund.

Much Work for Railroad-Valuation Engineer Precedes Advent of Government Forces

Jenks B. Jenkins, of Baltimore & Ohio, Has Evolved Comprehensive System for Showing Valuation Sections and for Lining Up Available Map Data

By C. W. STARK

Associate Editor, Engineering Record

IN THREE previous issues of the Engineering Record the writer has attempted to take from various vantage plants snapshots—the work is far too big for anything else—of what is being done and how much work is involved in the actual prosecution of the government evaluation of the carriers, irrespective of the much-discussed fundamental principles of valuation. The last of this series of pictures suggested the magnitude of the railroad's task in locating, assembling and classifying its available data concerning its plant. Perhaps a better conception of this preliminary work can be obtained from a railroad not yet in the thick of the inventory. The Baltimore & Ohio is one of the large roads that have not yet received notice from the government as to the date as of which they will be valued, and is not likely to be put under valuation for a year or more to come. Yet its valuation engineer, Jenks B. Jenkins, has been at work nearly three years getting acquainted with his road, indexing his records and clearing the decks for action. Following are a few of his activities along two lines only—the historical and geographical subdividing of the road for inventory purposes and the sizing up of available map data.

The first thing Mr. Jenkins did was to list his corporations and make a tentative list of valuation sections. The Baltimore & Ohio operated lines, including the Baltimore & Ohio Southwestern, together with affiliated lines under the jurisdiction of the valuation committee, have a route mileage of 5366 miles, and comprise sixty-five transportation corporations. In addition there are numerous subsidiary land-holding corporations and others owning personal property only. No mere "paper" corporations were listed. In compiling the list the status of 169 corporations was investigated and the total number to be finally listed was greatly reduced by the transfer of property from a number of corporations to others and the dissolution of the grantor corporations.

A part of the numerical list of corporations is shown. Where not preceded by any letter the corporation is a transportation corporation. The prefix B indicates a real estate company, while P preceding denotes a company owning personal property only, such as an equipment company. Effort has been made to have the subsidiary companies correspond in number to the transportation company in the same territory. Thus, 1 denotes the Baltimore & Ohio Railroad Company proper, R1 denotes the Real Estate & Improvement Company of Baltimore City, the general holding company for land all along the line, while P1 is the main equipment company. Similarly, R2 is the land company of 2, the Staten Island Rapid Transit Railway Company. The various symbols used in the column "Character of Control" are explained in the legend.

The corporations were grouped geographically, with gaps in the numbering to separate the groups. Thus, while the numbers 1–60 were assigned to the corporations east of the Ohio River, the numbers 53–60 are left open, thus separating the main group from the lines west of the Ohio, while other gaps divide the line into smaller groups. No. 21 begins the West Virginia series, No. 31 the Pennsylvania series, No. 81 the Chicago district and No. 91 the Baltimore & Ohio Southwestern.

VALUATION SECTIONS

With the corporations established, Mr. Jenkins began a tentative division of the whole road into valuation sections, which was the basis for a second, or "final," division. All corporation limits are, of course, section limits. So also are state lines. In addition the sections have been broken up for expediency at other points—junctions, division points, changes in operating, historical or construction conditions and the like—although such breaks were avoided unless deemed essential. While the government is empowered to fix the valuation sections, it is expected that those proposed by the railroad will be accepted.

As finally set off by the railroad the system has 146 valuation sections. They are numbered consecutively from 1, in geographical order, modified by the limits of operating divisions, with occasional gaps to allow revision of the sections. They are given a three-part designation—the corporation number, followed by an abbreviation of the state, followed in turn by the section number. Thus 91–OH–146 means valuation section 146, located in the state of Ohio, on the Baltimore & Ohio Southwestern.

Subnumerals and suffixes are used to distinguish the main line of a valuation section from its branches and owned or leased lines from trackage rights. The decimal .1 after the section number denotes the main or principal line and .2, .3, etc., denote branch or secondary lines—all exclusive of trackage rights over foreign lines. The suffixes a, b, c, etc., denote trackage rights over foreign lines. Corporations and sections in parenthesis are not under the jurisdiction of the valuation committee, but are included for indexing purposes.

NUMERICAL LIST OF CORPORATIONS
B. & O. SYSTEM AND AFFILIATED LINES

Symbols Used to Designate Character of Control

A	An active corporation
B	An inactive corporation
DC	Direct, sole control
DJC	Direct, joint control
IC	Indirect, sole control, through an intermediary
(——)	The Corporation Number of the intermediary
a	Control through ownership of stock
—%	Extent of interest of parent company or intermediary
*	Not operated
**	Under separate operation
***	Under foreign operation

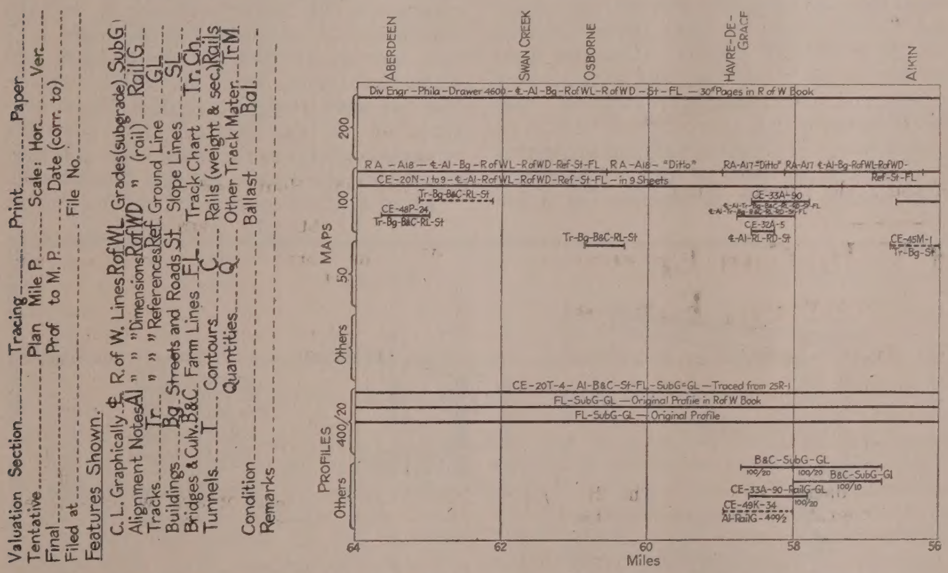
No.	Corporation	Character of Control
1	The Baltimore & Ohio Railroad Company	Parent
R1	The Real Estate & Improvement Company of Baltimore City	A–DCa–100%
P1	The Baltimore & Ohio Equipment Company	A–DCa–100%
P2	Baltimore & Ohio 26th Street Stores, Incorporated	A–DCa–100%
2	The Staten Island Rapid Transit Railway Company	A–DCa–100%**
R2	New York Transit & Terminal Company, Limited	A–IC(2)a–100%
(8)	(The Washington Terminal Company) (Joint with P. B. & W. R. R. Co.)	A–DJCa–50%**
9		
(R9)	(The Union Stock Yards Company of Baltimore County) (Joint with P. B. & W. R. R. Co.)	A–DJCa–50%

Symbol	Operating Division	VALUATION SECTIONS Description	Miles of 1st Track
1–MD–18	Baltimore	B. & O. R. R.—Washington Br.—Relay to Md.-D. C. Line and Branches.	
18.1	do.	Main Line—M. P. 9.0, Relay to Md.-D. C. Line	26.05
18.2	do.	Patuxent Br.—Savage to Guilford (The Guilford & Waltersville Granite Co. has trackage rights from derail, 1700′ S. of end of Branch to end of Branch, 0.32 mi.)	4.11
18.3	do.	Alexandria Br.—Pt. of Sw., E. Leg of Wye at Alexandria Jct. to Md.-D. C. Line	3.30
1–DC–19	do.	B. & O. R. R.—Lines in D. C.	
19.1	do.	Wash. Br., Wye and Metropolitan Branch—Md.-D. C. Line to D. C.-Md. Line	7.23
19.2	do.	Wash. Br.—Slip Switch, 12th St. Tower to Florida Avenue	0.81
19.3	do.	Wash. Br.—Coach Yard, Round House and Shops	——
19a	do.	Trackage over Wash. Ter. Co., Florida Ave. to Union Sta., Wash., D. C.	(0.72)
19.4	do.	Metropolitan Br.—Florida Ave. to Slip Switch at Rhode Island Ave. Tower, Bulk Freight Yard, Coal Yard and Track to L St.	0.92
19.5	do.	Alexandria Br.—Md.-D. C. Line to Shepherd	9.46
19b	do.	Trackage over P. B. & W. R. R., Anacostia Jct. to S. End Long Bridge	(4.60)
1–VA–20	do.	B. & O. R. R. Alexandria Br.—Freight Station at Alexandria, Va. (R. E. & I. Co.—R1–VA–19)	——

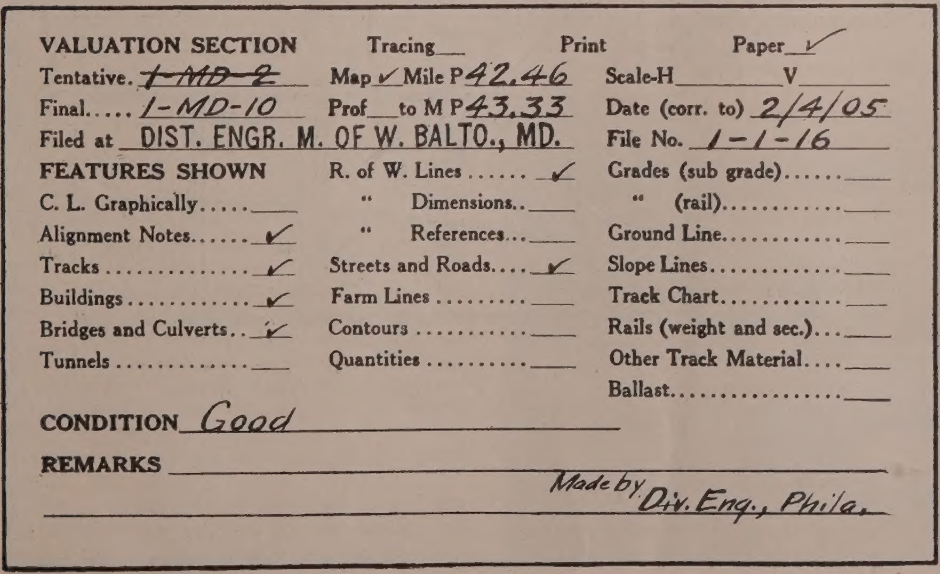
THESE TWO FORMS LIST AND DEFINE RESPECTIVELY THE CORPORATIONS MAKING UP THE SYSTEM AND THE FINAL VALUATION SECTIONS

Miles of first track in parenthesis are of trackage rights over the lines of other companies. One of the accompanying tables indicates the form in which the sections and subsections are listed and described.

A large map on a scale of 16 miles to the inch has been prepared, showing the valuation sections of the entire system. The successive use of three simple conventions—a plain solid line, one with cross bars singly and a third with them in pairs—makes it possible readily to see, without the use of color, the limits of each section, as no four sections come to a common point. Lines not yet constructed are dotted, and lines over which the company has trackage rights only are shown light. Each section is designated by its proper symbols. The map also shows state lines, principal bodies of water and watercourses, principal towns, stations or other points defining ends of sections and nothing else other than a legend and a tabulated list of the corporations.


Valuation Section.......Tracing.......Print.......Paper.......
Tentative.......Plan Mile P.......Scale: Hor.......Ver.......
Final.......Prof to M. P.......Date (corr. to).......
Filed at.......File No.......
Features Shown.
C. L. Graphically ℄ R. of W. Lines RofWL Grades(subgrade) SubG
Alignment Notes Al " " Dimensions RofWD " (rail) RailG
Tracks Tr " " References Ref. Ground Line GL
Buildings Bg Streets and Roads St Slope Lines SL
Bridges & Culv. B&C Farm Lines FL Track Chart Tr. Ch.
Tunnels T Contours C Rails (weight & sec.) Rails
Quantities Q Other Track Mater. TrM
Ballast Bal.
Condition
Remarks
ABERDEEN
SWAN CREEK
OSBORNE
HAVRE-DE-GRACF
AIKIN
Div Engr – Phila – Drawer 4600 – ℄-Al-Bg-RofWL-RofWD – St – FL — 30 Pages in R of W Book
RA – A18 — ℄-Al-Bg-RofWL-RofWD-Ref-St-FL
RA – A18 – "Ditto"
RA-A17 "Ditto"
RA-A17 ℄-Al-Bg-RofWL-RofWD-Ref-St-FL
CE-20N-1 to 9 – ℄-Al-RofWL-RofWD-Ref-St-FL – in 9 Sheets
Tr-Bg-B&C-RL-St
CE-48P-24
Tr-Bg-B&C-RL-St
Tr-Bg-B&C-RL-St
CE-33A-90
CE-32A-5
℄-Al-RL-RD-St
CE-45M-1
Tr-Bg-St
CE-20T-4 – Al-B&C-St-FL-SubG=GL — Traced from 25R-1
FL-SubG-GL — Original Profile in R of W Book
FL-SubG-GL — Original Profile
B&C-SubG-GL
100/20
100/20
B&C-SubG-GL
100/10
CE-33A-90-RailG-GL
100/20
CE-49K-34
Al-RailG-400/2
MAPS
200
100
50
Others
PROFILES
400/20
Others
64
62
60
58
56
Miles

DIAGRAMS VISUALIZE INFORMATION GIVEN IN CARD INDEX AND SHOW AT ONCE WHETHER TERRITORY IS PROPERLY COVERED



VALUATION SECTION Tracing___ Print___ Paper ✓

Tentative. ~~1-MD-2~~ Map ✓ Mile P 42.46 Scale-H___ V___

Final..... 1-MD-10 Prof___ to M P 43.33 Date (corr. to) 2/4/05

Filed at DIST. ENGR. M. OF W. BALTO., MD. **File No.** 1-1-16

FEATURES SHOWN	**R. of W. Lines** ...... ✓	**Grades (sub grade)**......
C. L. Graphically.....	" **Dimensions**..	" **(rail)**..........
Alignment Notes...... ✓	" **References**...	**Ground Line**..........
Tracks.............. ✓	**Streets and Roads**.... ✓	**Slope Lines**............
Buildings............ ✓	**Farm Lines**........	**Track Chart**..........
Bridges and Culverts.. ✓	**Contours**..........	**Rails (weight and sec.)**...
Tunnels............	**Quantities**.........	**Other Track Material**....
		Ballast................

CONDITION Good

REMARKS
Made by Div. Eng., Phila.

INDEX CARDS RECORD IN CONCISE FORM CHARACTER AND CONDITION OF MAPS

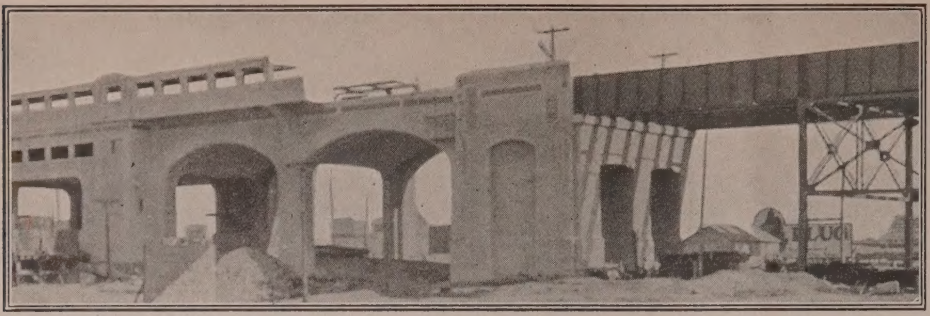
LINING UP THE AVAILABLE MAPS

Meanwhile, pending the "final" arrangement of valuation sections, Mr. Jenkins visited all of the map files of the company and noted the character, scope and condition of the maps and drawings found. His observations regarding maps have been recorded on an index card of the form shown, using the "tentative" valuation sections, which were later changed to the "final," for which space had been provided on the cards. Notice that only a few of the spaces require filling out; in the others the indication is made by a simple check mark.

Supplementary to the card index Mr. Jenkins has visualized the situation by diagrams, part of one of which is shown. These are plotted on profile paper, the vertical lines of which indicate distance as in an ordinary profile. Sections of the horizontal ruling are assigned to maps and to profiles and subdivided according to scale as indicated. Each heavy horizontal line means a map or profile for the territory from end to end of the line, full lines meaning that the map is good and dotted lines that it is inferior.

A form similar to that on the index cards—made in fact with the rubber stamp first used for the cards—is stamped on each end of each diagram. The blank spaces, however, are utilized to show suitable abbreviations, and by the proper selection of these symbols in the designation along the map lines the scope of each map is recorded. The small scale of the accompanying illustration precludes the possibility of labeling each line in the compact manner adopted on the original, but the few designations reproduced indicate the usefulness of the diagram.

As stated in the first paragraph, these are only a few of Mr. Jenkins's activities. A look at his primary list and a talk with him about the complications he has encountered regarding land ownership, crossing rights and many other matters will convince one that work can be found for the railroad-valuation department long before the advent of the government's field parties.



STEEL ELEVATED IN CONTRAST WITH DOMED CONCRETE STRUCTURE AT STATION

Elevated Railway of Domed Arch Construction a Strong Contrast to Steel Structure

Queens Boulevard Extension to New York System Has Incased Steel Girders and Reinforced-Concrete Arches Supporting Ballasted Floor

A STRIKING CONTRAST between the usual steel elevated railway and the new reinforced-concrete domed arch structure on Queens Boulevard can be seen from the car windows of the Long Island trains shortly after they emerge from the tunnel under the East River Where the ordinary steel type and the new arch type are joined, with the transition marked by a massive ornamental abutment, the contrast is impressive. Typical details of the steel structure, which is part of the Queens extension of the New York City Elevated Railway, were described in the Engineering Record of July 17, page 76.

The new Queens Boulevard elevated structure has the appearance of a reinforced-concrete dome construction. As a matter of fact, however, longitudinal arch action was assumed in the computations, and transverse steel girders embedded in the concrete at each bent carry the loading to the heavy reinforced-concrete columns. To increase the ornamental effect, recessed panels with tooled finish, inlaid colored tile and curved outlines are used. The mezzanine spans at the stations are steel girders and columns masked by concrete.

WHY ARCHED STRUCTURE WAS ADOPTED

Queens Boulevard is one of the most-used automobile highways leading from Long Island to New York City over the Queensboro Bridge. In order to furnish as ornamental an elevated structure at as low cost as practicable, the engineers of the Public Service Commission made several designs and estimates. A steel-frame structure of the usual type, with open floor, but masked by concrete, would probably deteriorate through the effect of impact on the bond between concrete and steel. A through solid floor which would decrease this danger was designed and estimated to cost over one and one-half times as much as the plain steel structure. The domed arch type of construction in reinforced concrete and steel, with steel girders and columns at every station, was adopted as a result of the study, as it was estimated to cost a little more than one and three-fourths times as much as the plain steel structure. Owing to the local conditions and the fact that a greater length would be required, the cost of subway construction would be about four times that of the usual steel structure.

The final decision was based not only upon relative cost and maintenance charges, but mainly upon the superior advantages of the arch structure for architectural treatment. An incidental advantage of importance is the decrease in noise resulting from the use of this type.

GENERAL DIMENSIONS

The Queens Boulevard section of the new Queens extension leading from Queens Plaza to Corona, L. I., is about ¾ mile long, running from Hill Street, just beyond the viaduct across the Long Island Railroad tracks, to Gosman Avenue. It carries three tracks on 13-ft. centers, two outside local tracks and one center express track. The width of the elevated structure is 42 ft. 6 in. inside the solid concrete railings projecting 2 ft. above the base of rail. These railings, which will be surmounted by a low pipe handrail, not only add to the height but to the possibilities of ornamental paneling on the outside, and aid somewhat in confining the noise of the passing trains.

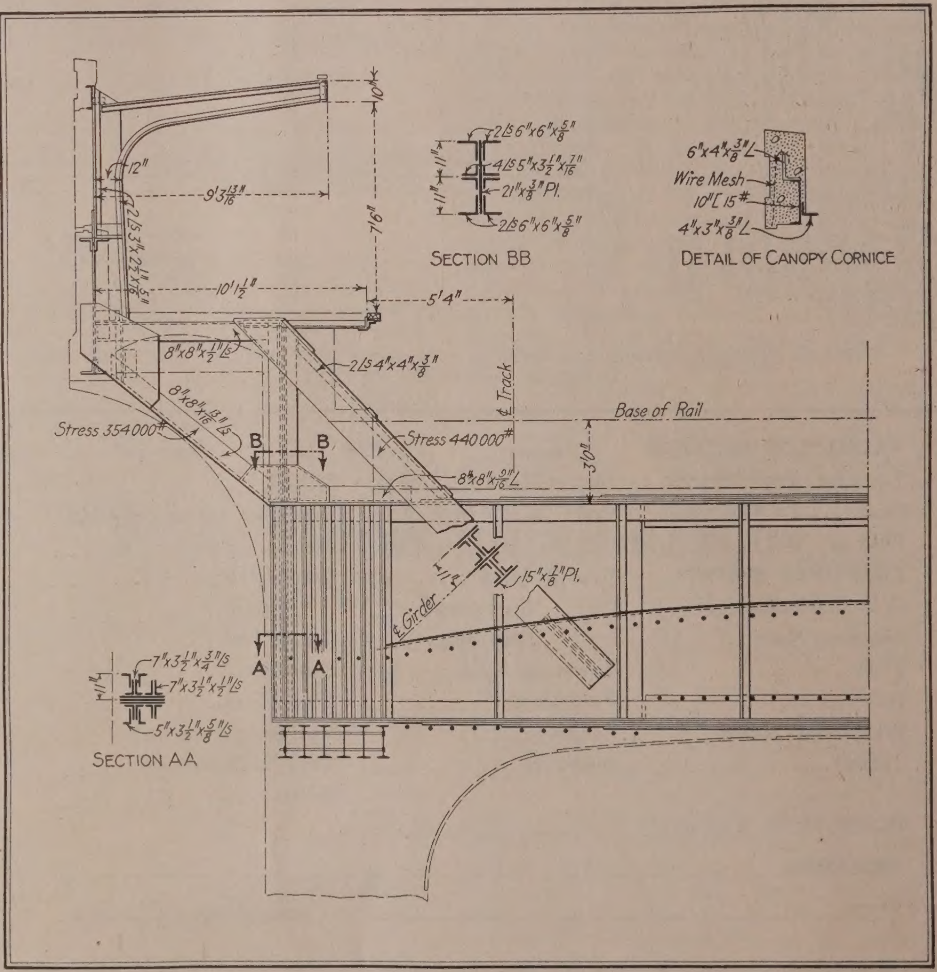
The typical span of the arches is 65 ft., while at the stations, where more room for the mezzanine floor and ticket offices is necessary, the span is increased to 90 ft., and steel plate girders covered by concrete are used. Except for the mezzanine span, the width at roadway level is not increased at the station, but the platforms are supported by cantilever brackets connected to the main cross-girders, and carrying fascia girders covered by concrete.

LOADS AND IMPACT

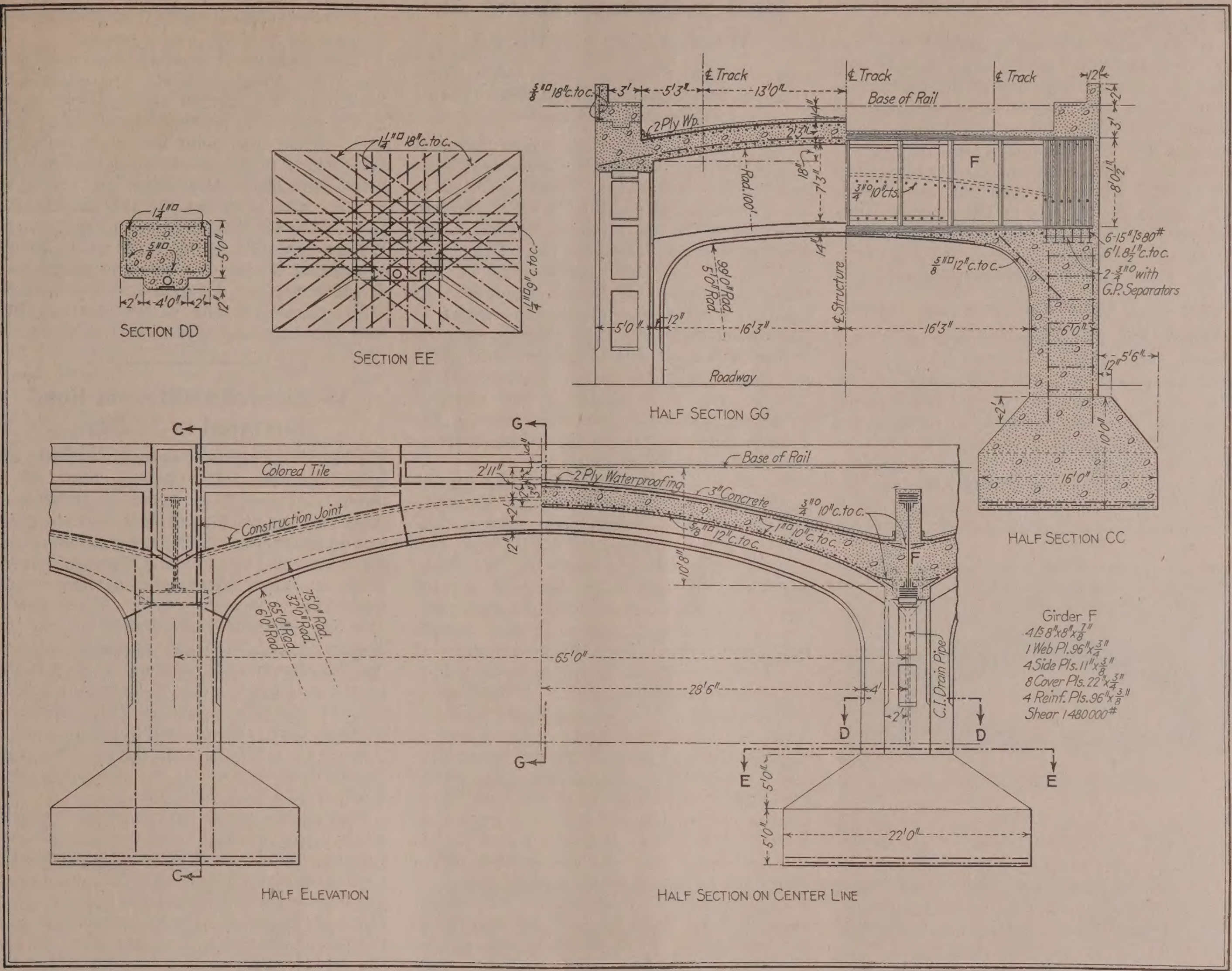
The structure is designed for 60-ton electric cars on each track, the two motor trucks of adjacent cars governing the arch analysis. The concentrated loads were assumed to be distributed by the ballast over 5 ft. longitudinally and 12 ft. transversely. In spite of the fact that these loads are transferred through ballast, impact was added at about 80 per cent of the live load, according to the Public Service Commission formula. In the design of the arches a temperature change of 30 deg. Fahr., rise or fall, was provided for.

The allowable unit compression in the concrete is 600 lb. per square inch, and the allowable soil pressure for the piers is 2 tons per square foot for direct loads and 4 tons maximum, including bending effects. For the steel girders and steel frame construction at the stations the allowable stresses conform to the usual values, as prescribed by the Public Service Commission.

After a preliminary trial outline for an



CONNECTION OF SIDEWALK CANTILEVER TO CROSS-GIRDER AVOIDS RIVETS IN TENSION



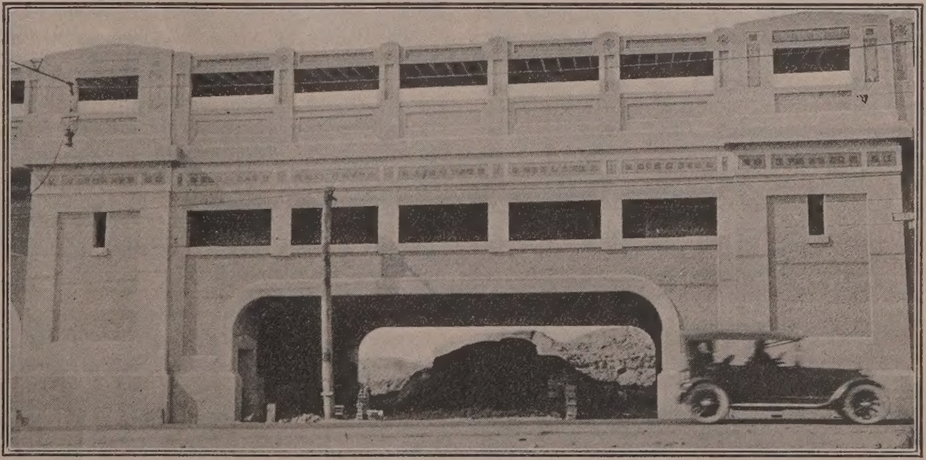
DETAILS OF TYPICAL 65-FOOT REINFORCED-CONCRETE ARCHES AND COLUMNS—STEEL CROSS-GIRDERS ON BEAM GRILLAGES

arch with 4-ft. rise had been found to give prohibitive stresses when temperature changes were considered, the outline shown in an accompanying drawing with three-centered circular curves for the intrados and a rise of 6½ ft. longitudinally and 1½ ft. transversely was adopted. A constant arch thickness of 2 ft. is kept from the crown to the quarter point and the thickness then gradually increased to about 4 ft. at the haunch. The longitudinal reinforcement is 1-in. square rods placed on 10-in. centers both top and bottom, with transverse rods ⅝ in. square spaced on 18-in. centers on the bottom only. A transverse arch effect at the bents is obtained by incasing the steel cross-girders in concrete with curved lower surfaces.

In computing stresses in the arch it was assumed that the concrete carried no tension, that the ends were fixed, and that the dead-load thrusts balanced each other at the cross-girders; that is, that the usual fixed-end arch analysis was applicable. In order to carry to the columns the heavy vertical components of the thrusts, it was found that reinforced-concrete arches were not practicable; therefore the steel plate girder was adopted.

The dead-load thrusts balance at the top of the columns, but the column design included the bending effect of unbalanced live loads. In computing this bending it was assumed that the total unbalanced thrust for one span loaded would be distributed equally to three bents. The heavy direct vertical loads and the effect of the bending required very large columns, 5 x 8 ft. in cross-section, with 1 in. square vertical rods, and ⅝-in. square rods for shrinkage, tied together by ½-in. hoops. The typical pier footing is 16 x 22 ft. in plan and 10 ft. deep, reinforced by 1¼-in. square rods both diagonally and, under the column section, parallel to the edges.

At the stations, of which there are three, the special cantilever bracket details shown in an accompanying drawing are used in the main cross-girders to support the outside fascia girders and platform loads. As noted on the members, the stresses in these brackets are very large. In order to avoid connections which would put the rivets under tensile stress, the ties, composed of two 15 x ⅞-in. plates, stiffened by two angles with tie plates, are spread far enough to pass the top flange angles of the cross-girders and allow the connection to be made

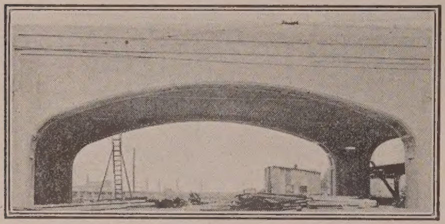


EFFECTIVE ORNAMENTAL DETAILS USED AT STATION by a diaphragm to the web of the girder, as shown.

At the 90-ft. mezzanine span of the station construction, where steel beams are used in the track floor and in the mezzanine floor, it was necessary to transfer the horizontal thrust from the adjacent arch spans by means of two horizontal steel plate girders at the level of the floors, with a grillage of vertical 20-in. I-beams between them. The expansion details at the station were complicated, and were generally designed to bring the expansion point at the edge of a panel where it would not be noticeable.

SURFACE FINISH—CONSTRUCTION JOINTS

Treatment given the concrete after the forms were removed resulted in a striking contrast produced by the light band around the sunken panels containing colored tile. These bands were finished by rubbing the concrete with carborundum brick. A 6-in. margin around the other panels is axe-finished in parallel lines, and the concrete inside the panel is given an attractive finish by removing the exterior mortar by pointed tools in air hammers. On the outside wall the panels are inlaid with green and yellow tile to give an effective mosaic border.



AS ARCH APPEARS BEFORE TREATMENT

The construction was begun July, 1913, but the first arch was not poured until June, 1914. Construction joints were located as shown on the drawing by dash lines. The wooden forms for the arches consisted of lagging supported upon transverse instead of longitudinal bents, since the transverse curvature is uniform for all spans and the bents could be used for the various spans simply by spacing them longitudinally as required. Concrete was handled in side-dump cars and 1-yd. bottom-dump buckets.

The work has been designed and executed as part of the city-built elevated lines covered by the dual-system contracts, under the general supervision of engineers of the New York Public Service Commission for the First District, of which Alfred Craven is chief engineer; Robert Ridgway, engineer of subway construction; D. L. Turner, deputy engineer of subway construction; Sverre Dahm, principal assistant engineer; A. I. Raisman, senior designing engineer, and Maurice E. Griest, assistant designing engineer. John H. Myers was division engineer and Robert H. Jacobs was senior assistant division engineer. Squire J. Vickers, designing architect, supervised the architectural treatment, and Noble & Woodard acted as consulting engineers. The contractor was the E. E. Smith Contracting Company, of New York City.

Appalachian Petroleum Production

The output of petroleum in the Appalachian field, which includes New York, Pennsylvania, West Virginia, Kentucky and southeastern Ohio, was 22,860,048 bbl. in 1915, a decrease of 1,241,000 bbl., or 5 per cent from the output of this field in 1914.

Bridge Damage Heavy in West Virginia Flood

Every County Structure Over Cabin Creek Swept Away—Chesapeake & Ohio Loss Estimated at $500,000

LACK of rain and river gages makes it impossible to state accurately the amount of precipitation which resulted in the flooding of the Cabin Creek district in West Virginia, as reported in the Engineering Record last week, page 244. The division of sanitary engineering of the State Department of Health, however, has detailed a corps of engineers to inquire of people who had wash tubs, barrels, etc., out in the rain as to the length of time taken for these containers to fill. Director Mayo Tolman, who is in charge of the work of collecting the flood data, has sent to the Engineering Record the following information about the storm damage:

"I am informed by people living on the headwaters of various streams that the storm was not a cloudburst, but an extremely heavy, continuous rain. I am told that the rain fell practically all day Tuesday, Aug. 8, and that the rain started again between 2 and 3 o'clock on the morning of Aug. 9 and continued as a terrific downpour until late the next morning. It should be noted that it was more a rush of water than a gradual rise. A number of people on Cabin Creek have stated that the water advanced as a fairly heavy wave.

"The storm evidently passed southeastward from Horse Creek on Coal River through Nelson and Kayford. At MacCorkle, on Coal River, a private gage registered 50 ft. This gage is set at 1 ft. below low water. By far the greatest property damage was done on Cabin Creek. I am informed by an official of the Chesapeake & Ohio Railway that the damage to that company's property alone will not be less than $350,000, and probably will mount up to $500,000. Heavy girders of 40 and 50-ft. spans were at some points carried over 100 yd. downstream.

BRIDGES FAIL BY SCOUR

"Apparently all the bridges failed by scour taking place under the downstream end of the piers. In some cases, however, the water swept out the fills back of the bridge abutments, and these abutments were forced over backward by the pressure of water or by masses of timber striking them, with the result that the girders dropped into the stream. The girders of a bridge above Sandy City have entirely disappeared; they probably are buried in the sand not far away. At many points only a corner or an edge of a heavy coal car can be seen above the sand. On Cabin Creek alone seventeen fair-sized railroad bridges were swept away. Not a single county road bridge in the entire length of the creek remains. In a great many places the alignment of the streams has been entirely changed. One or two railroad bridges remain standing, but these now span dry ground.

RAINFALL RECORDS

"The only records I have of rainfall at the present time are three—one at Carbon, on Cabin Creek, where an ordinary No. 2 galvanized iron washtub was filled in 20 minutes; at Eskdale the same sized washtub was filled in 40 minutes, and at Sang Creek the water rose 10 in. in an ordinary 31½-gal. barrel. At Eskdale I have one measurement showing that the water rose at least 34 ft. 4 in. above normal.

"The division of sanitary engineering of the West Virginia State Department of Health has established headquarters in the partly ruined Y. M. C. A. Building at Eskdale. From that point we are distributing antityphoid vaccine, chloride of lime and lime throughout the valley of the three rivers. The first day we inoculated 1126, and I estimate that 5000 will be immunized. We are disinfecting all wells with chloride of lime in order to insure the people safe drinking water. As soon as we disinfect a well it is posted with a sign stating, 'This well probably safe for drinking.'"

18 Miles of California Road Surfaced in 24 Days

RECENT improvements in methods and equipment for applying road oil to paved surfaces have made it possible to carry out the work so rapidly that the problem of delivering a sufficient quantity of hot oil at remote points on the highway has become an important factor in work on the California highway system. When the oil was applied from horse-drawn vehicles the application of 1500 gal. of heavy road oil per day was considered good work, but this bogy has been steadily increased, and during the present season 18 miles of paved surface were treated with a double application of oil in 24 working days. This work required six cars of oil, or an average daily delivery of about 3000 gal.

One of the motor trucks carries enough oil to cover about half a mile of road, so that on short hauls it is essential to the efficient progress of the work that ample provision is made in advance for the rapid covering of large areas with screenings. By the use of storage tanks along the road and the use of motor trucks for delivery it has been possible to carry out this work very rapidly. The cost of the finished job is influenced by the way in which the quantity of material was estimated, as well as in the method of delivery.

The careful and accurate dumping of the screenings, so that no material must be picked up after work is finished, makes for considerable cost reductions, and careful attention has been given to this detail. On a recent job near Fresno, by giving detailed instructions to truck drivers, the actual delivery of screenings varied from the computed requirements by less than one-half of 1 per cent.

Resident Engineers on Drainage Work Must Take Pictures

Each of the six resident engineers on the Little River Drainage District of Missouri is required to furnish as part of his own equipment a camera taking postcard size pictures. All monthly estimates must be accompanied by at least two photographs, typical views illustrating the character of the work accomplished. Where defective work is encountered and excepted to, views must be taken and submitted to the chief engineer, William A. O'Brien. In the office the photographs are mounted in a large loose-leaf book, eight prints on a page. They are arranged according to contracts and form a complete visual record of construction work on this half-million-acre project.

Long-Span Concrete Arched Bents Support Roof of Chicago Hebrew Institute

Theory of Analysis and Formulas for This Indeterminate Problem Given—Economy Results from Preliminary Designing of Forms

UNUSUALLY careful methods were applied in the design of both the main arched bents and the timber forms used in the construction of the new Hebrew Institute building in Chicago. By an analysis based upon the method of least work general formulas for arched bents have been developed and applied to this building. Formulas which neglect the variation in moment of inertia and formulas which include it are here given, and the effect in this particular case of neglecting variable sections is determined.

It is claimed that a notable economy resulted from the use of monolithic construction for columns and roof arches and from the careful preliminary design of the forms. Cantilever brackets that carry an 8-ft. running gallery and are tied into the main columns or carried by short columns below the gallery level are illustrated in detail.

GENERAL DIMENSIONS

The architectural requirements of the Hebrew Institute building were quite unusual. A high-arched roof and a needed clearance of 36 ft. above the main gymnasium floor made economical the use of reinforced-concrete arched bents of monolithic construction. These bents are spaced 16 ft. apart, with ten panels in the main body of the building, which is 160 ft. long and 98 ft. wide. The total length, including front and rear entrances, is 231 ft., and the total height above the ground floor is 52 ft., the footings extending about 5 ft. below it. The clear span of the arched roof over the high part of the building is 62 ft. 8 in., while a two-story section 16 ft. wide flanks the gymnasium on each side. In the rear of the building are two swimming pools of reinforced concrete, about 25 x 60 ft. in plan and 7 ft. deep.

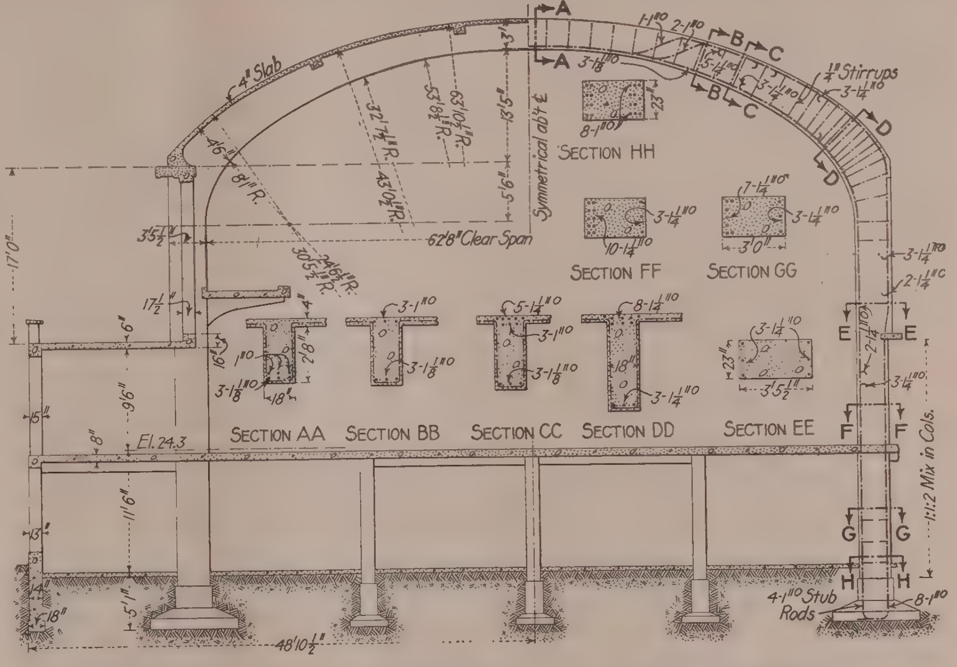
Cantilever brackets 15 ft. above the main floor of the gymnasium support the 7-in. slab of the running-track gallery. This slab, the roof slab of the two-story part and the 8-in. slab on the main floor act as struts to brace the main column and reduce the unsupported length.

ARCH ANALYSIS BY LEAST-WORK METHOD

The design of the arched bents supporting the roof beams and the slabs was made on the assumption that the columns are fixed-ended at the level of the gymnasium floor. A first analysis was made on the further assumption that the moment of inertia is constant throughout the length of the arch (I_1) and also constant for the columns (I). A second analysis to include the effect of variation in section for the columns and the arch was made and new formulas were developed. The relatively slight effect of the variation in section is indicated in the accompanying table, in which are given the principal moments and the thrust moment (Th) for each case, in terms of wl^2.

BENDING MOMENT COEFFICIENTS FOR wl^2

	Constant Moment of Inertia	Variable Moment of Inertia
Bending moment M_a at A....	0.0443	0.0392
Bending moment M_b at B....	0.0556	0.0564
Bending moment M_c at C....	0.0193	0.0208
Thrust moment Th at B......	0.1000	0.0956



HALF-SECTION OF MAIN GYMNASIUM SHOWS ARCH AND COLUMN REINFORCEMENT

These values were derived as follows:

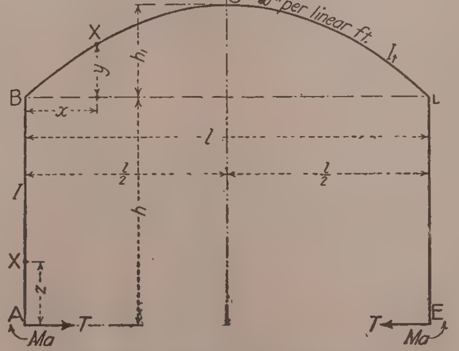
Consider the typical arched bent shown in the accompanying diagram, with the notation there given. Such a structure is, in general, indeterminate to the third degree. Assume a uniform load, w lb. load per foot, over the entire roof. On account of symmetry, the vertical reactions at A and E must be of the same magnitude, and equal to one-half of the total dead and live loads. Hence there remain two unknown quantities, the thrust T and the moment M_a, which can be obtained by the theory of least work, neglecting the small influence of the shortening of the arch. Using a parabolic arch center line, the equation of the arch with respect to an origin at B is

$$y = \frac{4h_1}{l^2}\ (lx - x^2)$$

Calling M the moment at any point X of the column or arch, and W the work done in bending only, neglecting the effect of direct thrust, there can be written:

For the column

$$M = M_a - Tz$$



OUTLINE DIAGRAM OF ARCHED BENTS

For the arch

$$M = M_a + \frac{w}{2}\ (lx - x^2) - T\,(h + y)$$

For work done, in general,

$$W = \int_A^E \frac{M^2 ds}{2EI}$$

Or, from symmetry,

$$W = 2\int_A^C \frac{M^2 ds}{2EI}$$

Applying the theory of least work:

$$\frac{dW}{dT} = 2\int_A^C \frac{M\ dM}{EI\ dT}\ ds = 0 \qquad (1)$$

$$\frac{dW}{dM_a} = 2\int_A^C \frac{M\ \ dM}{EI\ dM_a}\ ds = 0 \qquad (2)$$

Considering first the terms in equation 1, for the column AB:

$$\frac{dM}{dT} = -z$$

For the half arch BC:

$$\frac{dM}{dT} = -\,(h + y)$$

Substituting these values in equation 1 and integrating, after assuming ds equal to dz for the column and equal to dx for the arch, collecting terms and assuming that

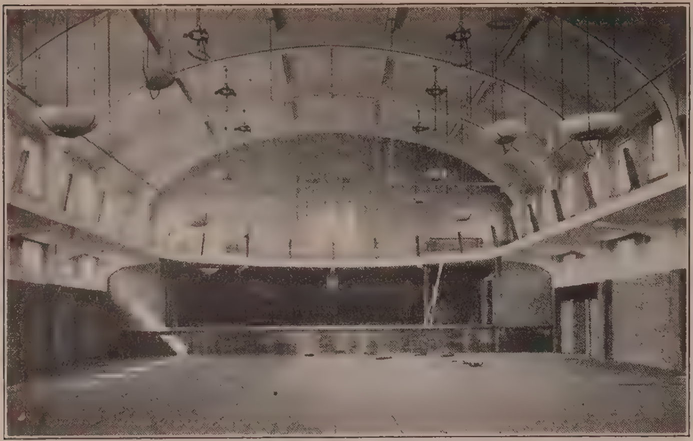
$$\frac{hI_1}{lI} = n \quad \text{and} \quad \frac{h_1}{h} = n_1$$

there is obtained:

$$M_a\left(1 + \frac{2}{3}\,n_1 + n\right) - Th\,\left(1 + \frac{4}{3}n_1 + \frac{8}{15}\,n_1^2 + \frac{2}{3}n\right) = -\,\frac{wl^2}{12}\left(1 + \frac{4}{5}\,n_1\right) \qquad (3)$$

Similarly, differentiating and substituting for the terms in equation 2, noting that for both the column AB and the half arch BC

$$\frac{dM}{dM_a} = 1$$



INTERIOR VIEW OF MAIN GYMNASIUM SHOWS ARCHED BENTS

ERECTING SPECIALLY DESIGNED FORMS FOR ARCHED BENTS

there is obtained:

$$M_a(1 + 2n) - Th\left(1 + \frac{2}{3}n_1 + n\right) = -\frac{wl^2}{12} \quad (4)$$

Applying these equations to the arched bents over the main gymnasium of the Chicago Hebrew Institute there is found that n_1 is approximately 0.5 and n is approximately 0.2. Substituting these values in equations 3 and 4:

$$1.533\,M_a - 1.933\,Th = -1.4\,\frac{wl^2}{12}$$

$$1.4\,M_a - 1.533\,Th = -\frac{wl^2}{12}$$

Solving, there is obtained:

$$Th = 0.1000wl^2 \text{ and } M_a = 0.0443wl^2$$

At the point B the bending moment is therefore

$$M_b = Th - M_a = 0.0556wl^2$$

and at the crown C the bending moment is:

$$M_c = M_a - \frac{wl^2}{8} - T\,(h + h_1) = 0.0193wl^2$$

When the variable moment of inertia was included in the analysis for this case, equations 3 and 4 reduced to the following:

$$M_a\,(1 + 0.75n_1 + 1.69n) - Th\,(1 + 1.5n_1 + 0.633n_1^2 + 1.0625n) = -\frac{3}{32}\,wl^2\,(1 + 0.845n_1)$$

and

$$M_a\,(1 + 3.75n_1) - Th\,(1 + 0.75n_1 + 1.69n) = -\frac{3}{32}\,wl^2$$

These equations are based upon the same values for I and I_1 as before. Substituting $n_1 \doteq 0.5$ and $n = 0.2$, and reducing, the values given in the table are found.

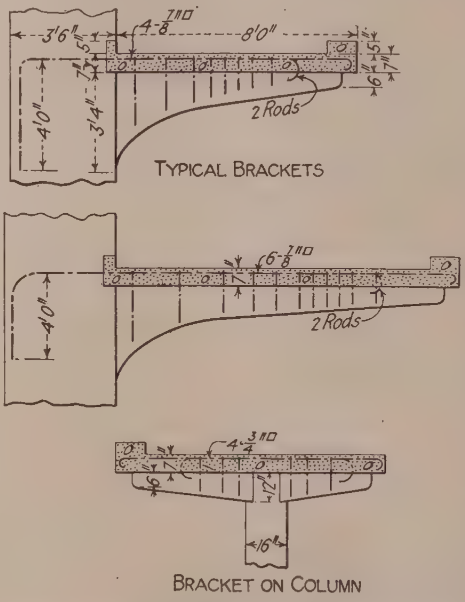
The arches were computed for an arch load of 2200 lb. per linear foot. As the loading upon the cantilever brackets supporting the running track tends to reduce the bending in the main columns, it was not considered in the analysis. The arch thrust T at the base of the column is resisted by four 1-in. round rods with 12-in. end hooks around the column steel and spliced by 4-ft. laps with similar end hooks.

Owing to the high stresses in the lower part of the column and the smaller size necessary for architectural purposes, a 1:1:2 mix was used below elevation 34 ft. 4 in., while the regular 1:2:4 mix was used above this level and for the arches. The manner of detailing the reinforcing steel in the columns and arches by hooked ends is worthy of special note.

All framework was carefully detailed beforehand and all forms were made on a platform on the ground and then erected into place, making possible a large saving in labor and in the total amount of lumber required in the forms. Almost without exception the form details called for mill lumber sized to width, obviating the usual necessity of ripping the lumber to fit the forms. Formwork was given such importance that there were many instances in which the amount of concrete was increased in order to save in forms.

A series of cleats which received battens for the forms were placed on the special platform so that the entire form could rest on an absolutely flat surface. The lumber was then laid down and a template placed over it and the form lumber marked and sawed to the required shape. Each longitudinal half of an arch form was built in a single piece, then cut in two, raised and set in place.

The bottom of the arch form was built up of three layers of ½-in. lumber for the circles of small radius and single pieces of 1-in. lumber for the circles of larger radius sprung into place. Battens in the columns and arches were spaced uniformly throughout, so that duplication of the formwork could be carried out with great rapidity. Due to the speed with which the work was being prosecuted, no forms were used twice. Instead, as many forms as possible were set up so that when pouring was started it could be continued throughout that portion of the building without stopping. The forms for the brackets supporting the running track were constructed with sheet metal bottoms to insure a smooth, even surface and to avoid expensive carpenter labor. In building the forms for columns and girders, 1-in. quarter-rounds were used at the corners to give a finished appearance.



TYPICAL BRACKETS

BRACKET ON COLUMN

THREE TYPES OF CANTILEVER BRACKETS SUPPORT RUNNING-TRACK SLAB

One of the arched bents was tested by applying twice the live load used in the design over one-half of the span. The resulting deflections and deformations were so small that they could not be measured, certainly less than 1/16 in.

The designer and contractor was L. J. Mensch, of Chicago, who furnished the foregoing design data. A. W. Bee was assistant engineer for the contractor. The architects were Ottenheimer, Stern & Reichert of Chicago.

Bitumen-Testing Needles with Constant Friction

Some Designs Proposed Will Not Correctly Indicate the True Comparative Consistency of the Material

By SAMUEL WHINERY
Consulting Engineer, New York City

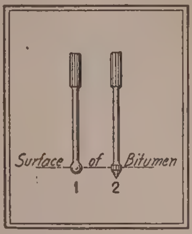
[*The author points out that certain proposed designs of needles for determining the penetration of bitumen and bituminous compounds displace varying volumes and have a variable frictional resistance at different depths of penetration. Therefore they give inconsistent comparative results. He proposes two designs which overcome the difficulties.*—EDITOR.]

A SUBCOMMITTEE of the American Society for Testing Materials, on penetration, in its report for 1915 recommended for standard use a parabolic needle having certain characteristics (*Proceedings* A. S. T. M., 1915). Recently Charles S. Reeves, chemist, and Fred P. Pritchard, assistant chemist, of the Office of Public Roads and Rural Engineering, Department of Agriculture, Washington, have recommended the use of a conical needle having a taper extending ¼ in. from the point (*Journal of Agricultural Research*, Washington, March 13, 1916). I think it may be worth while to call attention to the fact that the relative depth of penetration into bitumens of different hardness by either of these needles will not correctly indicate the true comparative consistency of the materials, though such needles may be used successfully to duplicate the consistency of a standard sample.

While the work done by a penetration

needle is as the product of the weight applied and the depth of penetration, the *consistency* of a bitumen is measured by the *resistance* of the material to the progress of the needle. This resistance is made up of two elements—one measured by the force required to displace, or cause to flow, a volume of bitumen equal to the submerged volume of the needle, and the other by that required to overcome the adhesion or friction between the bitumen and the submerged surface of the needle.

Neglecting the element of friction, we may say that the work required to cause a quantity of bitumen to flow is inversely as the consistency or hardness of the material and directly as the quantity and distance moved. The last-named factor is difficult to determine accurately, and for present purposes we may ignore it and safely say that the resistance is at least in inverse ratio to the volume of bitumen displaced by the needle.



FIGS. 1 AND 2

With a cylindrical needle the resisting work thus done would obviously be (disregarding friction) directly as the depth of penetration. But this is not true of parabolic or conical needles, because with these the volume of bitumen displaced increases as the square of the diameter of the needle at the surface of the bitumen multiplied by the depth of penetration.

To illustrate: Assume that a conical needle is used such that at a given distance from the point its diameter is 1, and that at twice that distance from the point the diameter is 1½. If with this needle it is found that the depth of penetration, with like units of weight and time, of one sample is 60 and of another sample is 30, it would be erroneous to assert that the second sample is just twice as hard as the first. For it may readily be computed that the quantity of bitumen displaced in the two cases is in the ratio of 4.5:1; but the work applied (being the weight applied multiplied by the depth of penetration) is, in the two cases respectively as 2:1. It appears therefore that comparing these two samples, while twice as much work was expended upon the first, 4.5 times as much bitumen was displaced; or, in other words, their true relative hardness is as 1:2.25.

It is true that such a needle is of steeper taper than those in common use, but the principle holds good with conical or parabolic needles whatever may be their dimensions.

RESULTS NOT PROPORTIONAL

A necessary corollary is that continuous penetration with such needles during equal increments of time will give different (decreasing) results for each period of time, as experiment has shown.

It is almost certain, though not so easily demonstrated, that with such needles the element of friction increases in a ratio greater than the depth of penetration, which would add still further to the error of assuming that consistency varies directly as the depth of penetration.

Some twenty years ago I designed and used a penetration needle intended to obviate the erroneous results pointed out in the foregoing. It has a spherical head or point and a shank of smaller diameter than the head, to avoid contact and friction with the walls of the cavity in the penetrated bitumen. This needle is shown on an exaggerated scale in Fig. 1. A modified form illustrated in Fig. 2 would doubtless give equally good results and would be more simple to make. In the use of either the enlarged head should be first submerged to its maximum diameter in the sample, as indicated in the sketches, and clamped there, to be released at the beginning of the penetration test.

It is apparent at a glance that the quantity of bitumen displaced in the test by this needle must be directly as the depth of penetration, and that the surface exposed to contact in the bitumen will be equal in area, and the friction a constant quantity at different depths of penetration.

It is not to be expected that scientifically accurate results can be attained by any such apparatus, particularly where the time factor is determined by the observation of the operator and more or less affected by his personal equation; but there is no reason why the apparatus used should not be designed in accordance with sound principleh so that results shall be theoretically correct.

TIMING DEVICE

In connection with the use of the needle described I designed and experimented with an electrical device for automatically controlling the time element in penetration tests, using a make-and-break attachment to the seconds hand of a clock which, by means of a magnet clamp, released and reclamped the needle, thus accurately controlling the time of penetration; but the stress of business prevented me from developing the device fully. I believe a device of this kind is very necessary for a satisfactory penetration apparatus.

Attention is again called to the matter in the hope that those now actively engaged in the study and use of bituminous materials may design and adopt standard penetration apparatus and methods that shall be free, in theory at least, from avoidable errors.

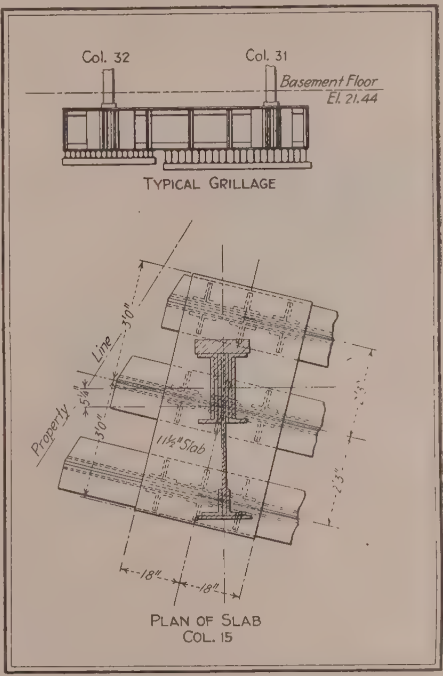
Irrigability of Lands

Secretary of the Interior Lane announces that during June more than 900,000 acres were designated as nonirrigable and rendered subject to entry under the provisions of the enlarged-homestead act.

Steel Girders and Concrete Struts for Foundations

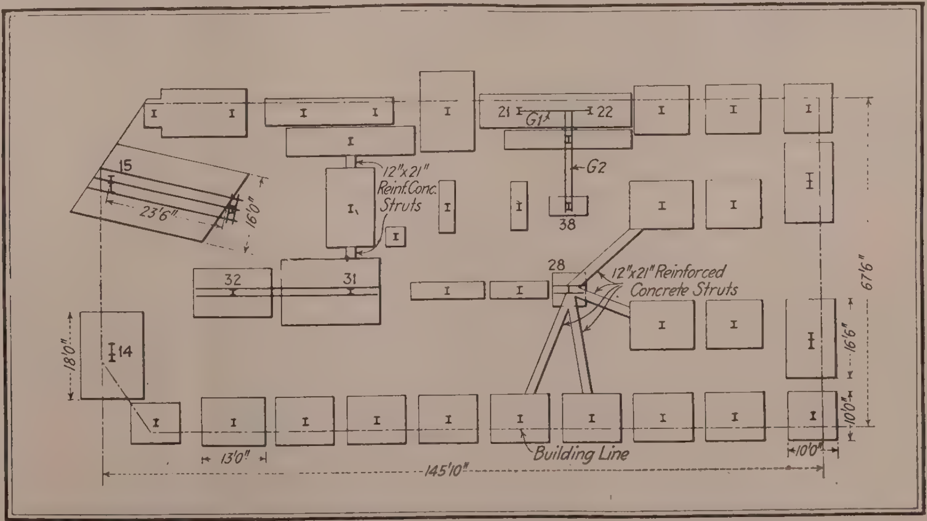
Bell Parkway Building, Philadelphia, Required Special Provisions in Substructure to Resist Wind Pressure and Uplift

SUPPLEMENTING the article describing the general layout, the architectural features and the steel-frame design of the Bell Parkway Building, Philadelphia, in the Engineering Record of May 27, page 712, the special foundation details here treated include the soil test to determine the allowable pressure, the built-up steel girders used to provide against wind uplift and the reinforced-concrete struts between column foundations to distribute the wind pressures.



GIRDER AND I-BEAM GRILLAGES

In general, the main columns are supported by steel slabs resting upon built-up steel grillage girders, which in turn are carried by rolled I-beam grillages, the whole incased in concrete. A 12-in. slab of concrete reinforced by ⅜-in. twisted rods on 12-in. centers supports the I-beam grillage. Owing to the presence of moving ground water, 10 per cent of hydrated lime was



GENERAL PLAN OF COLUMN FOUNDATIONS FOR BELL PARKWAY BUILDING added for the purpose of making the concrete protection of the columns waterproof.

The bearing soil at the site consists of a compact mixture of sand and gravel cemented together with a little clay, the gravel varying in size from pebbles up to one-man stone. This soil was tested to a total load of 9 tons per square foot, with a maximum settlement of less than ¼ in. for the last 7 tons, water being present when the test was made. There was practically no settlement in 23 hr. under 6 to 7½ tons standing load, and approximately only 1/64 in. settlement in 24 hr. under 9 tons standing load. The load was applied to a 4 x 4-ft. platform on a 12 x 12-in. post set in a pit about 2 ft. below the bottom of the column-footing level. Water from upper strata was flowing in a ditch in the excavation, and several times during the test the pumps stopped and water rose 6 in. above the bottom of the column-footing level.

Based upon the test, an allowable soil pressure of 6 tons per square foot was used in the design of the foundation for dead and live floor loads, with a 30-per cent allowable overload from wind.

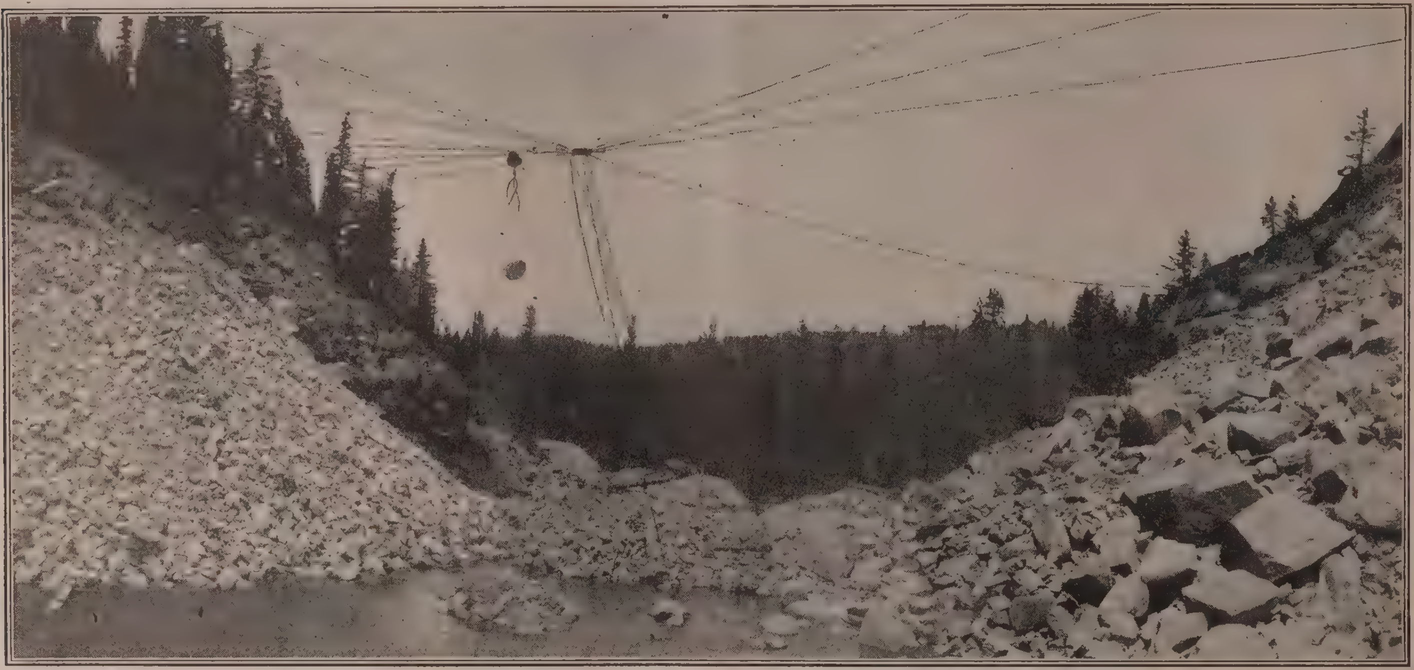
As indicated on the accompanying grillage plan, a steel double girder, G2, was designed to connect columns 38 and 40, cantilevering across the latter and passing about 2 in. below girder G1 connecting columns 21 and 22. This cantilever girder was required to take care of the possible 790,000-lb. net uplift due to wind pressure as resisted by the bracing between columns 28 and 38 and 40. This uplift was transferred to girder G1 by steel shim plates between the two girders and resisted by the ample loading on columns 21 and 22. It was considered best not to detail a rigid connection between the two girders.

A second unusual element in the foundation layout is seen in the use of concrete struts connecting various column foundations. These struts are all 12 x 21 in., reinforced by four 1-in. rods. They are provided for the purpose of distributing the lateral wind pressures brought to the foundations by the columns in the braced bays to adjacent column foundations.

Upstream Face of a Rockfill Dam Sealed with a Sliding Concrete Apron

Strawberry Dam Built with a Concave Face Covered by Concrete Slabs Without Bond—300,000 Cubic Yards of Rock Handled on Radial System of Aerial Cables

On the South Fork of the Stanislaus River in central California the Sierra & San Francisco Power Company is building what is known as the Strawberry Rockfill Dam, which is the second in a series of five storage dams contemplated in a progressive construction program for developing the hydraulic power of the South and Middle Forks of this river. Water stored by this dam will be used in a generating station to be built on the Middle Fork at a point which is 18 miles above a 40,000-kw. hydroelectric plant which the company already has in operation. Thus water stored on the South Fork in addition to its use in the upper plant will be available for the lower power house under a total head of 3300 ft.



DROPPING A 5-TON ROCK—BUMPER CLAMPED TO CABLE AT DESIRED POINT RELEASES LOAD AUTOMATICALLY

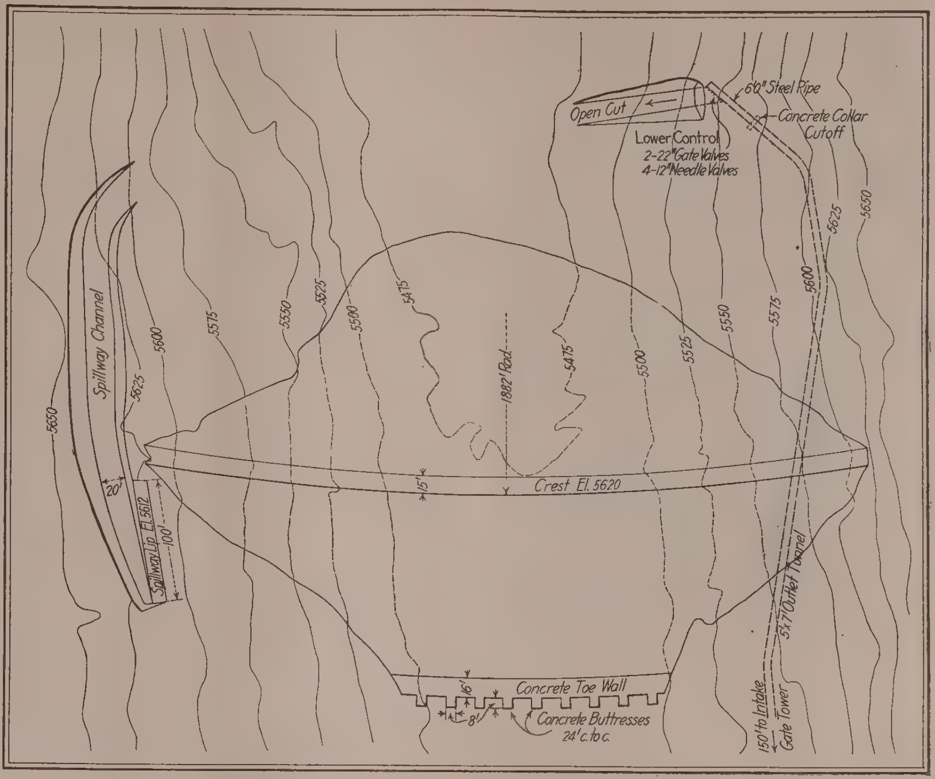
The dam is being constructed as a rockfill with a concrete cutoff wall and watertight facing on the upstream side. The rockfill will have a maximum height of 140 ft. above the river bed, while the concrete cutoff wall has been carried down to bedrock 33 ft. below the river bed. The width of the dam at the base in an up and down stream direction will be about 350 ft. In plan the dam is curved on a radius of 1880 ft., the structure being 612 ft. long on its crest. In addition to this curvature in the horizontal plane, the upstream face of the dam has been given a slight concave curve, as shown in the drawing, instead of the usual plane surface. This is expected to afford greater stability to the upstream face of the rockfill.

In laying out the construction plant it was decided to secure the granite of which the entire fill consists from seven quarries which were located on the banks of the cañon, in most cases above the level at which the rock would be deposited in the fill.

In order to convey this rock economically from quarry to fill, it was decided to deliver it by means of cables strung over the dam site, all centering at a point over the fill and terminating at the other end on the sidehill above each of the quarry sites. Accordingly a steel disk, ¾ in. thick and 48 in. in diameter, called the spider, was used as a hub or central terminus for the cables over the center of the site. The spider is held in place by the cables assisted by six 1¼-in. plowshare steel guy cables. These six guys radiate from the spider in such directions as to give the greatest stability to the spider, and are anchored against unequal tendencies from the load lines, anchorage being made to U-bolts grouted into rock in the hillsides. In addition to these guy cables and the seven carrier cables from the quarries, there are also provided one or more anchor cables leading from the spider directly down into the bed of the stream to prevent the rebound of the spider, which would otherwise result when skip loads of rock are suddenly released.

A carrier of original design was developed which makes it possible to hoist, trip and retrieve the rock skips with a single operating cable. The skip is unloaded by means of a bumper, clamped to the cable at the point where it is desired to dump the load, which releases a trigger on the carrier and automatically trips the skip. After the carrier is drawn back to a position above the quarry another device clamped to the cable at this point is so arranged that the carrier is automatically latched in position while the skip is lowered into the quarry or raised again to the carrier by simply operating the one cable. The latch is automatically released when the skip is raised to the carrier, and the carrier with its load is then allowed to slide down the line by gravity, subject to check by the single cable, until the bumper is struck.

The location of the bumpers for releasing loads can be changed readily by loosening



PLAN OF STRAWBERRY ROCKFILL DAM AND POSITION OF CONCRETE TOE WALL

the clamp and sliding the bumper along to a new position. The exact location of the spider, which is always the lowest point in the cable system, is changed by lengthening or shortening the several cables, and with these two adjustments it has been found possible to dump rock directly onto all parts of the fill. The carriers on each cable are operated by 6¼ x 10-in. hoisting engines driven by compressed air at 110 lb. per square inch. On account of the numerous rock-drill equipments installed in the several quarries it was thought best to operate all plants by compressed air, and a $30,000 air-compressor equipment was accordingly installed for construction purposes.

The entire operating force engaged in handling rock consists usually of 15 men to each carrier cable. This includes quarry crew, powder monkeys, engineer, foreman, etc. With seven quarries operating, an average of about 1000 cu. yd. of rock per 10-hr. day is handled continuously, the monthly average being from 29,000 to 33,000 cu. yd. The total amount of rock in the completed structure will be about 400,000 cu. yd., of which 300,000 cu. yd. is being deposited by the cableway system. The maximum delivery distance from quarry to spider is about 800 ft.

SLIDING WATERTIGHT APRON

The upstream face of the fill is being finished off with a dry masonry wall, as shown in one of the illustrations. Italian and Greek artisans who have become skilled in the work in their native countries are used in building the wall, and it has been found possible to make good progress while limiting the maximum depression or projection to less than 3 in. from the theoretical face of the curved surface as determined by instrument. This becomes even more notable when it is stated that the rock units used in the wall vary from 3 to 5 tons in weight and are placed by derrick. Each rock is wedged tightly between those adjoining with spalls and rock wedges and carried back from the face of the rockfill so that the dry masonry wall is an integral part of the fill itself.

On this dry masonry wall, which affords a comparatively smooth, solid surface, a 3-in. paving of cement mortar is placed, which gives an almost perfectly true surface. Over this mortar surface a ½-ply layer of Malthoid roofing is laid, and the face of the structure is then ready for the sliding concrete apron.

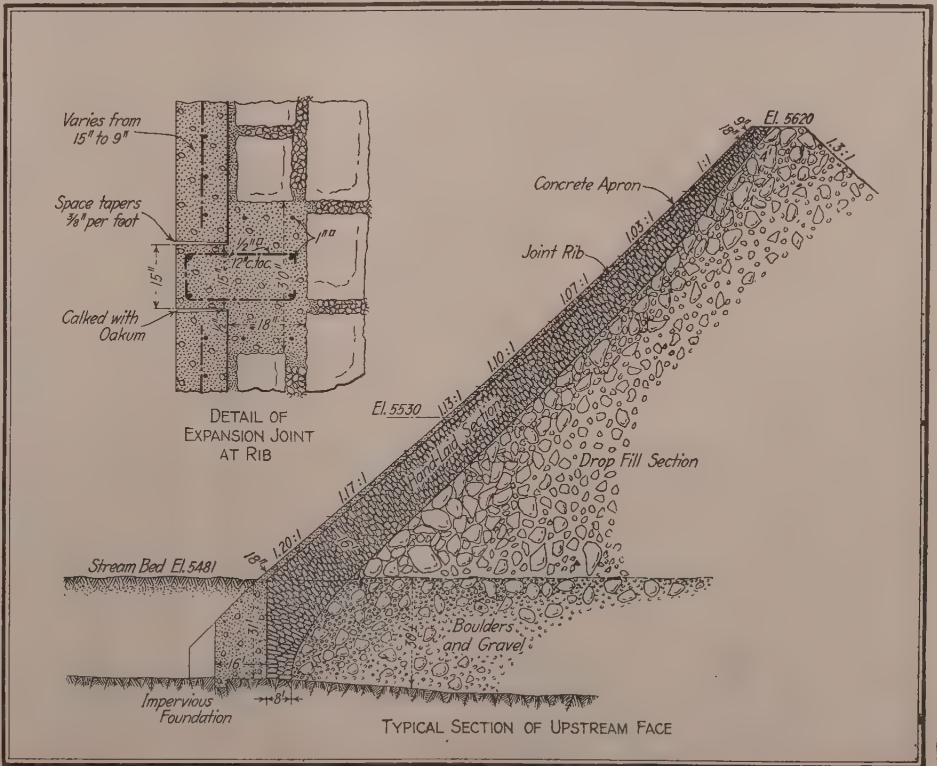
In designing the apron for the dam, settlement of the loose fill and movement of the apron caused by temperature changes are anticipated. Accordingly it was decided to use a reinforced-concrete apron on the upstream face, cast and bonded directly to the rock face for the lower 50 ft. of the dam, but free to move on the face of the dam proper as the latter shifted in course of settlement or from temperature stresses. This apron is being cast in 60-ft. widths, which abut against, and make watertight joints with, concrete ribs that project from the dam proper at 60-ft. intervals.

The sliding apron is 18 in. in thickness from the toe wall up to El. 5530, the beginning of the sliding plane. At this elevation the 18-in. thickness is split into a 3-in. plastered section and a 15-in. sliding apron. Above this point the apron thickness steadily decreases to 9 in. at the crest. The reinforcement of the apron consists of vertical and horizontal reinforcing bars. The vertical reinforcement in the lower third of the apron consists of 1-in. square deformed bars spaced on 9-in. centers, while in the upper two-thirds the size is reduced to ¾-in. square bars on 9-in. centers.

Water for power purposes passes from the reservoir through a 5 x 7-ft. outlet tunnel driven through solid granite at one end of the dam. The upper end of this tunnel is surmounted by a concrete tower in whose walls are located six 30-in. sluice gates operated from the top of the tower. At the lower end of the tunnel there is provided an auxiliary control composed of four needle valves and two gate valves.

The duplicate control systems at either end of the tunnel permit of repair work without the loss of the stored water. This arrangement of control units permits the use of one or both of the gate valves for fixed quantities of flow, while the more exact regulation is made possible by means of the needle valves, which can be used effectively for making slight changes in the quantity of flow. Delicate regulation is desirable owing to the great value of this water for power purposes through the total head of 3300 ft.

The spillway is not located on the dam proper, but is adjacent to one end of the



DETAIL OF EXPANSION JOINT AT RIB

TYPICAL SECTION OF UPSTREAM FACE

SECTIONAL VIEW OF UPSTREAM TOE OF DRY MASONRY WALL

SECTION OF UPSTREAM FACE OF DAM

structure where a discharge channel was excavated in solid rock. This channel was the location of three of the quarries from which rock from the dam was taken, so that its construction entailed no extra expense. The spillway lip, which is at a level 8 ft. below the top of the rockfill, is 100 ft. long and has a capacity four times the maximum recorded discharge from the drainage basin above the dam. The spillway is to be equipped for 3-ft. flashboards, which will bring the maximum high water level 5 ft. below the crest of the dam.

DESIGNING AND CONSTRUCTION PERSONNEL

The dam is being built for the Sierra & San Francisco Power Company by Chadwick & Sykes, general contractors, who designed and patented the single-cable carrier. H. L. Livingston is superintendent for the contractors. Ford, Bacon & Davis, New York City, prepared the plans and estimates, and are general engineers for the power company. J. S. Maloney is superintendent for the power company and F. I. Doane is assistant engineer. The work is being carried out under the direction of H. F. Jackson, vice-president and general manager of the power company, under the immediate supervision of George W. Howson, in general charge of extensions of the power company's hydroelectric development.

RIBS, PART OF PLASTERED SURFACE AND FORMS FOR PORTION OF CONCRETE APRON

Washington Systematizes Subsurface Mapping

Municipal Department and Public Utilities Co-operate in Making Permanent Records of Underground Structures

By ASA E. PHILLIPS
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THE interesting article in the Engineering Record of Dec. 25, 1915, page 792, entitled "Seattle Utilities Pay City for Subsurface Maps," furnishes a valuable addition to the meager published data on this important subject, as well as a new and somewhat radical point of view as to the means by which these useful and necessary municipal records are to be obtained. The contrast that is drawn between the means and methods at Seattle and the means and methods at Cincinnati, as detailed in the Engineering Record of Jan. 9, 1915, page 38, would probably require considerable modification were the local conditions in each case considered. As with most subjects of human interest, particularly those of an engineering nature, these local factors, both as to physical conditions and as to laws and regulations, usually differ so widely as to make fair comparisons of either work or methods hardly possible without complete local knowledge. Doubtless this was true in the case at hand.

METHOD OF FINANCING SEATTLE MAPPING OBJECTIONABLE

But however this may be, at least from a point of view of broad application, it would certainly appear that the method of financing the Seattle mapping, as described in the above-mentioned article, is open to fundamental objection, while the statement that the city secures these maps "without costing the taxpayers anything" indicates such a departure from the principles that should govern civic administration as to invite at least the closest scrutiny. It is to be presumed that public utilities in Seattle as well as elsewhere are taxpayers, even as are individuals, and it is clearly unethical that these utilities should be required to furnish gratuitously to the municipality service maps showing the publicly owned functions. So that if such is the practice at Seattle, as this article appears rather triumphantly to indicate, the contrast with the method at Cincinnati of directly appropriating public funds for this work does not seem quite so commendatory nor so worthy of imitation as might at first appear.

For many years careful consideration has been given to the mapping of underground construction in the District of Columbia and very complete records are kept of all work of this character. It is about twenty years since the writer began the preparation of the first complete set of standard large-scale maps of the city of Washington, showing underground construction from actual field surveys. These maps were on sheets 22 x 30 in. to a scale of 1:600. About 200 sheets formed the original set of drainage and sewerage maps, after which sets of water and paving maps were subsequently prepared.

Within the past few years the writer has instituted the preparation of a much more elaborate set of maps on a scale of 1:120, plotted on similar sheets, each 22 x 30 in., to cover the more closely built-in area of the downtown section, required by the complicated subsurface construction of recent years. All this mapping is done from field measurements taken in great detail and recorded in loose-leaf field books. After plotting and checking the field sheets are filed for reference under a carefully co-ordinated card-index system.

WHAT THE MAPS SHOW

These maps show all sewers, water mains, gas mains and power, telephone and telegraph conduits, as well as vaults, building projections, curbs and street-railway tracks. The underground construction is shown in soft tints of various colors, while building lines and projections, curbs, railway tracks and other surface work are shown by light india-ink lines. The general appearance of the sheets is artistic and attractive, without any sacrifice as to clearness and legibility. These maps are constructed on heavy mounted drawing paper of the best quality.

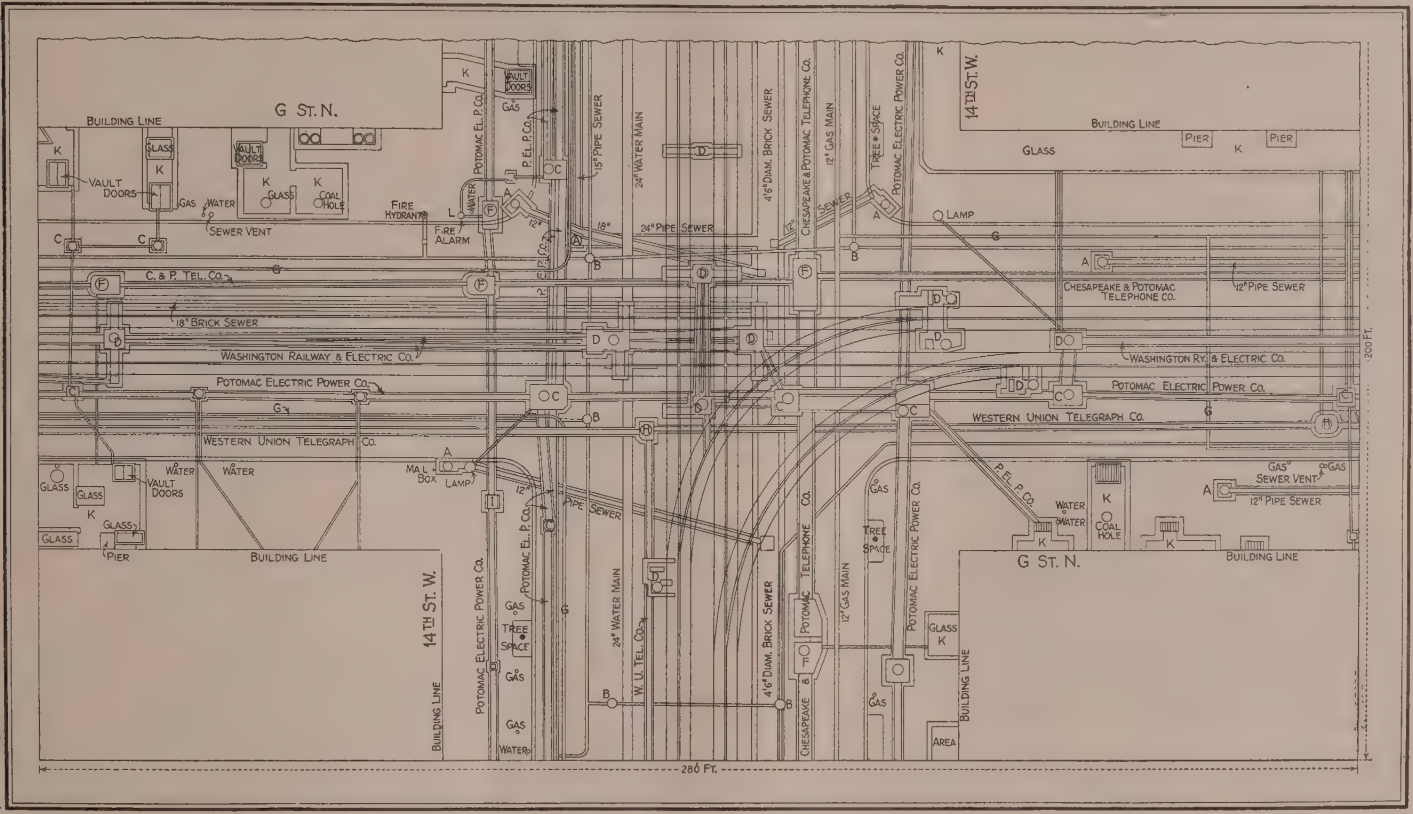
This represents what has been done in the way of primary maps. From the original set of 1:600 sewerage maps, tracings were prepared showing only building, curb and other surface lines, and from these photo-lithic reproductions on mounted drawing paper were obtained, one set of these ground maps for a complete record of gas mains, and sets for all telephone, telegraph and power conduits, the latter being shown in colors to indicate the construction of the several companies. Blueprints from these tracings, as well as prints from VanDyke negatives, have been exceedingly useful for special studies, as well as in connection with the underground surveys.

SCALE OF MAPS

The system of 1:600 scale mapping has proved very satisfactory except for areas within the business or semi-business districts, where the 1:120 maps are a necessary feature. It has been found desirable, if not practically necessary, on maps of a scale 1:600 to confine the record to one character of construction if the best results are to be obtained.

Probably few cities in the country have so complex an installation of underground construction as Washington, where for many years all overhead wires have been prohibited by Congress. Some idea of the extent of the mapping required may be obtained when one recalls that the area of the District of Columbia is very nearly 70 square miles, much of which is subdivided and partly built up.

For a number of years all the underground construction of the public service corporations in the District of Columbia has been under the charge of the writer, who has carefully organized this work. Accurate locations are fixed for each piece of construction on definite, predetermined lines, in advance of issuing permits for the work, and during its progress all construction is regularly inspected. Field locations and measurements are made immediately on completion of the work, from which record sheets are prepared showing the details of each construction, and the work is also plotted on the record maps in precisely the same manner as the publicly owned construction is recorded.



THIS MAP FORMS THE STANDARD RECORD OF UNDERGROUND CONSTRUCTION IN WASHINGTON

The various subsurface lines are differentiated by colors as follows: A—Sewers, Vermilion; B—Water Mains, Blue; C—Potomac Electric Power Company, Carmine; D—Washington Railway & Electric Company, Carmine; E—Capital Traction Company, Violet; F—Chesapeake & Potomac Telephone Company, Green; G—Washington Gas Light Company, Brown; H—Western Union Telegraph Company, Orange; I—Postal Telegraph Cable Company, Orange; K—Private Vaults, Black; L—City Electric Conduits, Yellow.

The cost of this supervision is charged to the public service companies, and is prorated among them in accordance with the actual amount of construction of each. A monthly statement is rendered to each corporation showing in detail the work done under each permit, giving location, etc., and the cost charged in each case. Detail accounts are kept and unit costs determined each month for each kind of construction.

DISTRIBUTION OF COSTS

At the outset, in organizing this work, it was believed that these municipal records would prove a valuable asset to each corporation, fully justifying the expenditure involved, as well as being of great value to the municipality. So a plan was worked out equitably covering the distribution of costs, and the matter presented to the several companies, with the result that arrangements for the payment for the work were accomplished without difficulty by voluntary agreement.

This was in 1908, and to the present time there has been no complaint in a single instance, either as to matters of supervisory control or as to the costs charged for this work. On the contrary, the department has had at all times only courteous agreement, appreciative understanding and active assistance from the officials of the various companies in this rather difficult administration. At the same time strict consideration has been given to obtaining uniform and proper locations for the various underground structures without regard to questions of merely local or temporary expediency, such as would cheapen the immediate construction at the expense of permanency and good location, and always with a view to the greatest possible conservation of the public space. Equal consideration has been given to securing good construction and the proper handling of construction work. It is believed that the results thus far satisfactorily attained have been due to rigidly impartial treatment, to a spirit of reasonable fairness and the absence of arbitrary dictation, to an expeditious handling of the business so as not to delay work and, perhaps most of all, to a genuine spirit of helpfulness in meeting conditions and solving the various problems that have arisen.

COMPARATIVE COST OF MAPS

COST OF 1:600 MAPS

	Maximum	Minimum	Mean
Field locations........	$12.50	$2.80	$9.46
Ground map	16.10	1.40	4.22
Finished map	15.96	4.13	8.18
Complete map	36.80	9.22	21.88

COST OF 1:120 MAPS

	Maximum	Minimum	Mean
Field locations........	$39.20	$8.92	$21.00
Ground map	12.04	1.20	2.85
Finished map	41.34	6.86	23.27
Complete map	86.22	17.24	49.16

Perhaps of all comparisons in engineering work that of costs is most misleading. Again we have the generally troublesome and complex local conditions to consider, while the inclusion or exclusion, in whole or in part, of administrative and overhead charges is sufficient to vitiate such comparison. To eliminate as far as practicable these disturbing factors it is to be understood in the foregoing table as to the cost of the Washington map work that all overhead is excluded as well as cost of equipment and materials used in the work, but that every item connected with the work which may be classified as labor is embraced in the figures.

Costs are given separately for (a) field work, including transportation; (b) ground map—that is, with all street, alley and curb lines plotted and inked ready for mapping the subsurface construction; and (c) finished map, which includes plotting and checking the underground, tinting, inking and lettering. These costs per sheet, both for the 1:600 and the 1:120 maps, with the maximum, minimum and mean in each case, are shown in the table.

As stated, the 1:600 maps show the sewerage system only, while the 1:120 maps show all the underground construction, as well as other features not shown on the former, and in addition show the structures in considerable detail, and cover only the most complex and difficult city areas. Reduced to a unit basis of ground areas mapped, the cost per acre for the 1:600 scale was 61 cents and for the 1:120 scale $37.82. The percentage of street area to total for the former is 45 per cent and for the latter 60 per cent.

Diagrams for Cost of Placing Steel Reinforcement

Effect of Variable Weight per Foot Included to Eliminate Inaccuracy of Estimates Based Upon Costs per Ton

By DAN PATCH
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ANOTHER application of graphical representation to the interpretation of data, in which the cost of placing reinforcement in concrete structures is put upon a much more accurate basis, is presented in the accompanying diagrams. Labor cost in placing steel is usually rated in dollars per ton, although it is recognized that such unit costs increase when light steel is being placed. In order properly to include the effect of size of rods, a graphical method based on weight per running foot of steel has been devised.

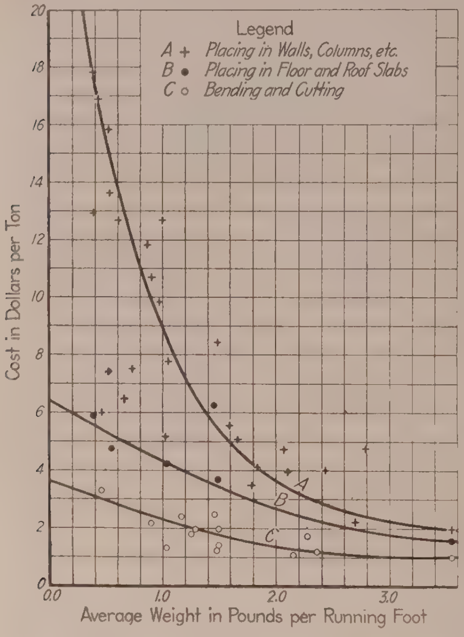


FIG. 1—CHART FOR COST OF REINFORCING STEEL BASED ON WEIGHT PER FOOT

LITTLE ADDED WORK REQUIRED

The unit costs are usually obtained by dividing the labor cost figured from the timekeeper's sheets by the tons of steel reported placed by the quantity man. In order to obtain data for studying the effect of size of bars, only one more item must be recorded—the total length of bars placed. This is easily done by the use of a listing adding machine, by which the total running feet of each diameter of rods placed can be obtained. The daily totals are tabulated in terms of rod sizes and linear feet placed, the total length and total weight computed, and the average weight per running foot easily obtained. Knowing total cost and total tonnage, the cost per ton is found, and plotted on the diagrams as shown in Fig. 1.

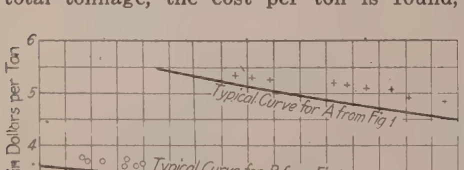


FIG. 2—TYPICAL EXAMPLES OF COSTS AT VARIOUS DATES COMPARED WITH CURVES IN FIG. 1

The curves *A*, *B* and *C*, which are drawn through the fields of plotted points obtained for costs of placing in wall, columns, stairs, etc., in floor and roof slabs, and of bending and cutting respectively, indicate the large effects of average weight upon the cost of labor per ton.

If additional argument in favor of accounting for the weight variable is necessary it will be found in the curves of Fig. 2. This diagram shows on a larger scale the plotted costs for the same kind of work, but for different dates, the steel growing lighter as the roof is approached. Sections of the typical curves of Fig. 1 to this enlarged scale are shown, the costs of placing in walls, columns, etc. (Curve *A*), giving the clearer illustration.

USE OF TYPICAL CURVES

As an example of the value of these curves, consider the figures on the work recorded in Fig. 2. On Nov. 23 the cost per ton was $4.83. By Jan. 19 this cost had risen to $5.34 per ton. With these figures only and no knowledge of the weight of steel it would be assumed that the work was being less efficiently done, but with the typical curve as a basis of comparison it will be noted on Fig. 2 that while there has been a 10-per cent increase in the cost per ton, the typical cost curve *A* has been more nearly approached, indicating the increased efficiency that can reasonably be expected as a job progresses and the men become more accustomed to their work.

The results obtained in this study lead to speculation as to whether similar curves would not be valuable in eliminating the variation in floor-form costs resulting from differences in thickness of slab and floor heights; in the costs of laying and jointing drains and sewers on account of differences in diameter; in the cost of setting sash as a result of differences in size of openings, etc. There is a wide field for the use of graphics in cost work.

Reports Year's Progress on New York Highways

Deputy Commissioner H. E. Breed Gives Cost Figures and Describes Work Done in Testing Road-Building Materials

LAST year's progress in the construction of the New York State highway system is discussed in the annual report of H. Eltinge Breed, first deputy commissioner, made public this week. Mr. Breed presents figures showing the costs of pavements of the several types constructed during 1915, discusses certain improvements in construction to provide for motor truck traffic and describes the procedure followed by the bureau of tests in determining the suitability of such materials as stone and sand for road building. Extracts from the report follow:

MILEAGE OF ROADS

During 1915 1073 miles of road were placed under contract. There were on Jan. 1, 1915, 749 miles of work under contract and remaining to be completed. During the year 759.61 miles of road were actually completed and accepted, while 323.74 additional miles of work were completed, but too late for acceptance, making a total of 1083.35 miles of road completed during the year. On Jan. 1, 1916, there were 739 miles of work uncompleted and under contract.

TYPES AND COSTS

Of the 1073 miles awarded 381 miles are of waterbound macadam; 176 miles of waterbound macadam, surface treatment; 347 miles of bituminous macadam, penetration method; 2.2 miles of bituminous macadam, mixed method; 113 miles of cement concrete pavement; 31 miles of brick; 23 miles of all other types; totalling 1073.2 miles.

The following data of the cost of construction for the different types of pavement were obtained, Mr. Breed states, by taking those pavements which total 6 in. in thickness. These cover in general the average condition of to-day. (In the cost per mile figures the 16 ft. refers to the paved width and the 26 ft. to the total width, including earth shoulders and ditches.)

COSTS OF CONSTRUCTION

Waterbound Macadam

Cost per square yard of pavement only......	$0.648
Cost per mile of 16-26 ft. highway..........	10,250

The cost per square yard was obtained from 434 values and the cost per mile from 419 values.

Bituminous Macadam

Cost per square yard of pavement only......	$0.871
Cost per mile of 16-26 ft. highway..........	12,970

Both of these items were obtained from the average of 134 highways.

First-Class Concrete, 6 In. Thick

Cost per square yard of pavement only......	$1.121
Cost per mile of 16-26 ft. highway..........	15,320

Both of these items were obtained from an average of 20 highways.

Brick Pavement on 5-In. Concrete Foundation

Cost per square yard of pavement only......	$2.015
Cost per mile of 16-26 ft. highway..........	25,750

These were obtained from an average of 23 highways.

CONSTRUCTION

In all construction the department has been widening the pavement proper on curves and banking it in order that the fast-moving motor traffic might be better safeguarded against accident. The slopes have been cut back and the clearing carried far enough along the inside of the curve to insure better sight distance for users of the road. Greater radius, wherever possible, has been given to the curve, in many cases to the extent of purchasing additional right of way.

During the past year the department has increased the depth of pavements because of the large increase in the use of motor vehicles. There were 208,087 pleasure cars licensed in the state in the past year, and 23,585 commercial cars. Motors of both the pleasure and commercial type seem to be the greatest destructive agents. The increased use of commercial trucks and the damage done by them to the highways, according to Mr. Breed, are alarming. Many of the old roads which were built only 6 in. in thickness have already begun to break up under this traffic, particularly at seasons of the year when ground water seeps through the soil under the pavement making it wet and unstable. At these times the vibratory action caused by the pounding from impact and by shifting of the heavy moving loads creates a shear in the pavement such as to break its bond. Raveling follows, and unless immediately taken care of the pavement rapidly disintegrates and failure is the result. As a factor against this the department has been increasing the use of cut-off drain tile and designing roads of greater thickness—from 9 to 12 in. of stone, according to the soil and traffic conditions to be encountered. It has also been the policy to build quite a number of miles of concrete roads, as these, Mr. Breed states, seem more adequately to meet this class of traffic.

An attempt was made in the season of 1915 to forestall any early disintegration of a green macadam road by providing for an application of bituminous material and screenings to be placed before the expiration of the contract. In some cases, Mr. Breed reports, this worked out well, while in many others, especially in those where the roads were finished late in the fall, the macadam surface was not sufficiently seasoned to unite with the surface treatment. On later contracts, and during the present year, this difficulty was overcome by providing two methods for surface protection. Such portions of the macadam as have been under traffic for three months and are thoroughly seasoned are to be protected by the bituminous surface application as before, and the remaining portion which is still in a curative state is to be treated with an application of calcium chloride for temporary protection against raveling.

"In dealing with the materials situation we have endeavored to change our specifications so as to afford the greatest amount of competition along every line. This has received some commendation, and I think will result in obtaining better prices for the different articles considered, as well as in eliminating such monopolies as result from restricted specifications admitting only one or two articles of a kind," is one of the comments made by Mr. Breed.

Bureau of Tests

There have been many improvements in the method of conducting the large amount of work done during the past year in the Bureau of Tests. Besides standardizing and expediting the work, instruction has been given to field engineers in charge of construction work so that they have been better able to gage the materials with which they are working and their peculiarities. This instruction is given through theoretical as well as practical work in the laboratory, and also from time to time in the field. This work has been supplemented by reporting to the field engineers the results of all tests on materials where such reports would enable them to know better the quality of the material to be used and would give them better working knowledge for construction.

Sands

The testing of sand has never been given the relative importance that is required for good work, according to Mr. Breed. In the increase in the building of concrete pavements, greater consideration given to the quality of the sand used has shown that a good result is in many cases dependent upon this important ingredient. Previous to 1915 compression tests were made on sand mortars of 3-in. cubes at an age of 14 days. The only available data were based on this size of cube. However, the department has made several hundred comparative tests on 2-in. cubes as well, so that reliable data have been secured on which to base results. The 2-in. cube is now used exclusively in sand testing. These cubes are broken at 7 and 28 days and, as the quality of the material can be judged at 7 days, this has reduced the necessary time for the sand test from 14 to 7 days, expediting very much the work of the contractor. By this method it has also been possible to make more cubes and to study slow set and low strength action to better advantage.

Concrete Cubes

The making of concrete cubes in the field and the testing of them in the laboratory have proved very valuable in determining more accurately the quality of the concrete in the work. There were 1,444 such cubes tested and the following tabulation is given to show the average results obtained:

STRENGTH OF CONCRETE CUBES

Concrete Mix	Average compression, lb. per sq. in.	No. of cubes
1—1½—3	3620	796
1—2½—5 (crushed stone)	1935	222
1—2½—5 (gravel)	1755	200
1—2½—5 (all cubes)	1875	474
1—3½—4 1—3—4½ } (mostly slag)	2140	56

Cubes showing compression below 3000 lb. per square inch for 1:1½:3 and 1800 lb. per square inch for 1:2½:5 are considered below the desirable grade. There were 25.8 per cent of these in 1914 and 10.95 per cent in 1915. All cubes showing a compression below this desirable grade are carefully inspected to try to determine to what the low strength is due. Any of them which show indications of carelessness in the mix are returned to the division office with laboratory comments.

The following is a tabulation of the low cubes during 1915 and reasons which seem to cause the low break, with percentage of the same:

CAUSE OF LOW BREAK	Per Cent
Sand dirty, containing loam and also dirt from subgrade	35.4
Stone or gravel coated	35.0
Sand too fine	8.5
Poor quality of stone or gravel	8.2
Poor manipulation in making cubes	4.7
Lack of proper mixing	3.5
Miscellaneous, too wet, etc	4.7

All concrete cubes have heretofore been tested 28 days after casting. This period was chosen because comparative data were available on compression for concrete at this age. During 1915 enough cubes were broken at an age of 7 days to give sufficient data to judge of the quality of the material when broken at this age. Testing at this period will enable us to correct any faulty condition more promptly. It will still be necessary to test occasional 28-day cubes as a check on the increase in strength.

Single-Track Roads in New York

The New York State Highway Department has built near Syracuse 6 miles of single-track road, with a paved width of 8 ft. Contrary to usual custom in building hard-surface roads, the paved section is not in the center of the right-of-way or of the traveled strip, but to one side. The road in question is one which carries most of the loads in one direction, the returning wagons being practically all light. The concrete pavement is put on the side with the heavy traffic. By placing the pavement to one side of the center, and giving it the same crown as a standard 16-ft. road it will be possible at a later date, if the returning traffic becomes sufficiently heavy, to lay another 8-ft. width, giving a 16-ft. paved road. The construction is being carefully watched and if it proves satisfactory the highway department expects to use more of the same type.

Sand Dredged from River for Road Work

Screening Plant for California Highway Construction Takes Material from Creek Bottom — Freshets Continually Renew Supply

MUCH DIFFICULTY has been encountered by the California Highway Commission in many parts of the system in making satisfactory arrangement for a good quality of sand to be used in constructing concrete pavements. Private capital is often unwilling to develop the best deposits; it is hard to secure prompt deliveries, and the execution of workable agreements with contractors has been a source of trouble. The commission decided, therefore, wherever feasible to develop sand deposits of its own, and a thorough examination of all conveniently located deposits was made and a report submitted by the commission's geological force.

COMPLETE CYCLE FOR A BUCKET LOAD OF SAND CONSUMES 1 MINUTE

The plant near San Luis Obispo affords an example of how this plan can be made to work out. Here a cableway excavator was constructed which takes sand from the bed of the Salinas River and delivers it to a washing, screening and storing plant above a railroad spur at a point where delivery can be made into freight cars by gravity.

Operated at Profit

In addition to the benefits derived from the elimination of delays and contract difficulties and the ability to control the uniformity of the product, it has been found that the Salinas plant has been operated at a considerable profit, if the sand used is figured at the usual contract price. Furthermore, the installation is considered practically permanent because the winter freshets annually bring down quantities of high-grade sand and gravel sufficient completely to fill the pits excavated during the summer months. The elevation of the screening plant above the river bed is such that it is above flood water level, and continuous production through twelve months of the year has been found to be possible by storing quantities before the flood season.

The dredging equipment consists of 700

ft. of 1½-in. steel cable used as a standing line and on which a traveling excavator is operated on the carrier. The bucket has a capacity of ¾ cu. yd., and is run by lighter cable passing through a sheave in the carrier. One end of the standing line is anchored in a concrete deadman on the far bank of the river and the other end is attached to the top of a 70-ft. mast on a knoll just above the bunkers. The storage capacity is about 4000 cu. yd. in bins and stockpile.

The operating equipment installed at the plant consists of a 40-hp. steam boiler, burning fuel oil, which drives cylindrical screens that grade the sand and gravel. The total cost of the plant in operating condition, including a 700-ft. railroad spur for handling freight cars, was about $7,000. It was put in operation on May 1, 1915, and since that date has produced 27,000 tons of screened material at a cost of approximately $6,650, or 25 cents per ton, including royalties.

SAND PLANT IN OPERATION PREVIOUS TO COMPLETION OF RECEIVING HOPPER

At the usual rate paid for these materials it is figured that the total cost of the installation to date is $400 less than the cost of this material to the commission under the old conditions. In other words, the commission has saved $400 and has in addition the equipment, which is expected to be useful for a long term of years.

A. B. Fletcher is chief engineer of the California State Highway Commission. Walter C. Howe is resident engineer of Division S.

Bermuda Motor-Car Prohibition to Be Modified

The legislative assembly of Bermuda has decided to repeal the present act prohibiting the use of mechanically propelled vehicles of all sorts, and has appointed a committee to draft a bill providing for "a restricted motorbus service under the control of the local government." It is probable that a bill, drafted in accordance with the motion, will pass both the assembly and the legislative council, in which case a motorbus service, under prescribed restrictions, will be inaugurated between Hamilton and St. George and between Hamilton and Somerset.

Calcium Chloride Hastens Seasoning of Concrete

Compressive Tests of Mortar and Concrete Show Large Percentages of Increase in Strength at Various Ages

CALCIUM CHLORIDE added to the mixing water to an amount of 4 per cent by weight will increase by large percentages the rapidity with which concrete gains strength. This conclusion has been reached as the result of a series of tests made at the U. S. Bureau of Standards at Washington, in which the effects of various chemicals were studied in an effort to find a good accelerator for hardening concrete. While the time of setting was not materially affected by adding calcium chloride, there was no difficulty experienced in handling the concrete to which it had been added. Standard 1:3 mortar cubes and standard cylinders of 1:2:4 and 1:1½:3 concrete were tested in compression at varying ages up to 30 days.

PRELIMINARY TESTS

In order to determine what chemical compound would prove most effective in causing the strength to develop more rapidly, preliminary tests were made on 2-in. cubes of 1:3 mortar, using Saylor cement and standard Ottawa sand, tested at the ages of 24 and 48 hours. Fig. 1 indicates graphically the results of these compressive tests, the horizontal lines representing the strength obtained for plain mortar.

The most effective percentage of calcium chloride was determined by testing two mixes of concrete, using various brands of cement, with Potomac River sand and gravel, as indicated in Fig. 2. Standard 8 x 16-in. cylinders were used, stored in air and tested at the age of 48 hours. The results indicate clearly that 3 or 4 per cent gives maximum strength.

Tests to determine the time of setting, using neat cement pats, showed little or no effect for the calcium chloride added in amounts from 1 to 5 per cent.

The effects of the addition of 4 per cent of calcium chloride to standard test cylinders of two mixes of concrete, using Potomac River sand and gravel, tested at ages of 1, 2, 3 and 30 days, are indicated in Fig. 3, in which it is shown that in all cases except one the strength was increased for all the brands tested.

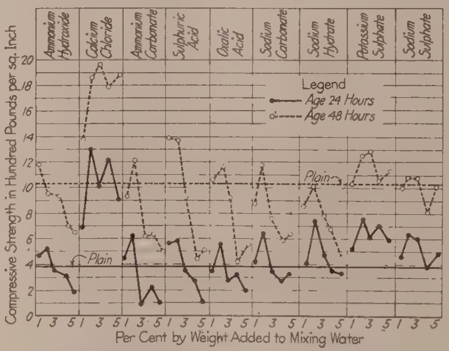


FIG. 1—CALCIUM CHLORIDE MOST EFFECTIVE IN INCREASING STRENGTH OF 1:3 MORTAR

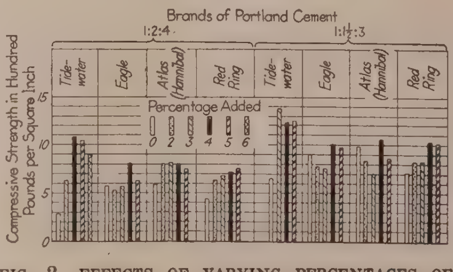


FIG. 2—EFFECTS OF VARYING PERCENTAGES OF CALCIUM CHLORIDE IN CONCRETE

To determine the effect of the manner of storing test pieces upon the strength both with and without the addition of 4 per cent of calcium chloride, standard cylinders were stored in air for 24 hours and then in water until tested at the ages of 3 days and 30 days. The results show some increase at both ages over the strength of the test pieces stored in air, both for the calcium-chloride specimens and for the plain specimens.

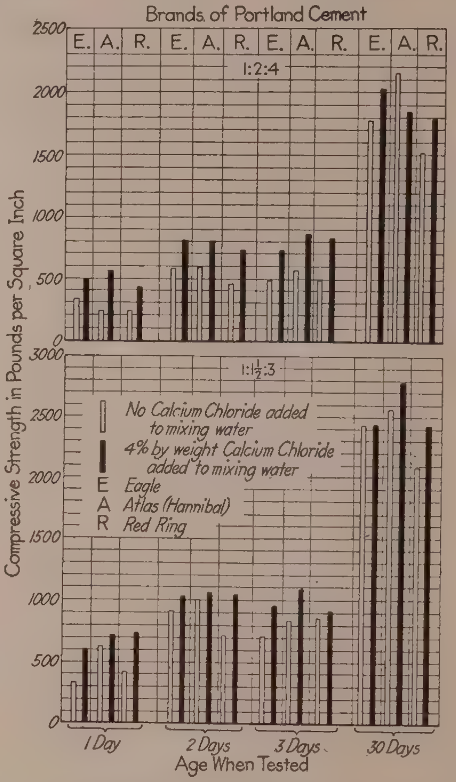


FIG. 3—INCREASE IN STRENGTH OF CONCRETE DUE TO 4 PER CENT CALCIUM CHLORIDE

CONCLUSIONS

Tests of the 1:3 standard sand mortar show that the rate of hardening is accelerated most by the addition of calcium chloride, which increases the strength at 24 hours by from 155 to 230 per cent and at 48 hours by from 173 to 190 per cent over the strength of mortar containing no calcium chloride.

The best percentage of calcium chloride to use for all proportions of concrete is from 3 to 4 per cent of the weight of the mixing water. The increase in strength at 48 hours thus obtained varies from 14 to 275 per cent for the 1:2:4 mix and from 11 to 110 per cent for the 1:1½:3 mix.

In all but one case the concretes mixed with 4 per cent of calcium chloride show greater strength for both mixes than for plain concrete, these results being consistent, though variable, for all the ages tested, up to 30 days. This acceleration in strength is believed to be due to the more complete hydration of the silicates and aluminates in the setting of the cement.

The use of calcium chloride increases the cost of concrete by 12 to 15 cents per cubic yard. For best results it is important that the concrete be mixed to a quaking, but not fluid, consistency. Calcium chloride should be used with caution for reinforced-concrete construction, as it tends to accelerate any corrosion of the steel which may occur.

This work was conducted under the immediate supervision of R. J. Wig, engineer of tests, at the U. S. Bureau of Standards, Washington, of which S. W. Stratton is director.

Motor Trucks Descend Into Deep Building Excavation

Handled Easily and Loaded with Steam Shovels in Digging Basement for Pennsylvania Hotel in New York

Ninety thousand yards of earth and rock are being removed by loading motor trucks on the pit floor with steam shovels in excavating 40 ft. below curb for the new Pennsylvania Hotel, between Thirty-second and Thirty-third streets on Seventh Avenue, New York City. The excavation is being carried down in two main lifts, one to rock and the next to grade. In both operations, as many motor trucks as the hauling contractor could furnish, supplemented by teams, are being employed. Teams are also used where hand loading is required in cleaning up.

Pennsylvania Tubes Uncovered

The lot is approximately 236 ft. along Seventh Avenue by 400 ft. deep. Thirty-third Street is more heavily traveled than Thirty-second, which is a stub street facing the Pennsylvania Terminal, and as the Seventh Avenue side is blocked by the new subway construction, two runways on about 20 per cent grade were located leading to Thirty-second Street. The surface of the lot was well covered by the cellars of the brick tenements removed to make way for the hotel. This made it possible for the shovels to start in at a low level and dig downgrade to the roof of the Long Island tunnels along the north side of the lot. The earth was next pretty well removed and excavation of the rock between the Long Island tunnels and the Pennsylvania tunnels, which cross the south side of the lot, was begun. It is this part of the basement that extends 40 ft. below curb.

LOOKING EAST, SHOWING RUNWAY TO BE REMOVED—TEAMS STANDING ON LONG ISLAND TUNNELS

The easterly runway will be taken out as soon as all the remaining earth excavation is finished, and only the runway nearest Seventh Avenue will be used. This descends on to the concrete roof of the Long Island tunnels, which has several vertical steps of 12 to 18 in. over which the trucks must climb loaded in going out. From this roof the trucks descend into the rock excavation on grades of 6 to 8 per cent. These grades can be climbed with a 6-cu. yd. load, but where a truck halts on a grade to load, a snatch team of three horses helps it to start. Double-drum electric hoists, using a line from each drum hooked to the forward part of the frame, pull the trucks up the main runways and also let them down. Two men attend each runway, one to handle the lines and one to hook on a 6 x 6-in. timber, which bumps along the runway behind each ascending truck to chock it in case of an accident to the hoist or lines.

STARTING UP THE INCLINE

START OF ROCK EXCAVATION AND RUNWAY UP WHICH IT WILL BE TAKEN IN MOTOR TRUCKS

Trucks Easily Handled in Pit

The trucks require some planking in the pit, especially to protect the rubber tires on the rock surface. They make nothing of little irregularities, however, and maneuver around the lot without loss of time. While both the ½-yd. and the 1-yd. shovels were busy in earth, nine of these trucks took out 525 cu. yd. a shift, and at present, with the excavation in transition from earth to rock and roadways being rearranged, six of them are removing 270 cu. yd. a shift. The earth yardage handled by the trucks represents a little more than half the output of the shovels, the remainder having been removed in 3-yd. dump wagons. It is stated, however, that had the hauling contractor been able to supply trucks, not a team would have been used, except for cleaning up. The rock excavation, having to be blasted in small charges because of the location, will be slower, and the trucks will handle nearly all of it.

The trucks and teams make a 1½ mile round trip to Thirtieth Street and the North River, the trucks averaging eight trips per 8-hour shift at present. When faster loading with earth was in progress, the trucks averaged twenty-four trips for the two shifts from 8 a. m. to midnight, no work being done on the third shift.

The hotel is being built by the George A. Fuller Company for the owners, the Pennsylvania Railroad. Jacob Fradus is disposing of the excavation for the contractor.

Oxyacetylene Torch Widens Cable-Line Slot

In San Francisco an oxyacetylene torch has been used for widening the cable line slots of the United Railroads. Where electric lines cross the cable routes the slot tends to close up on account of expansion in the heavy electric rails. Heretofore it has been necessary to take out the pavement and shove back the crossing in order to open up the slot. Instead a thin strip is now cut off one side of the slot rail by means of the torch. On a heavy manganese double crossing, making a cut 46 ft. long, the cost has been $19, as against a cost of approximately $150 by the old method.

Lays Transverse Fissures to Manufacture

Dr. P. H. Dudley of New York Central Lines Declares That Interior Fissures Can and Should Be Avoided

THAT interior transverse fissures in rail heads are induced by a combination of two or more exceptional conditions of manufacture in an occasional rail head by direct rolling, which can and should be avoided, is the contention made in a report, just made public by A. H. Smith, president of the New York Central System, by Dr. P. H. Dudley, consulting engineer of the system. Briefly, Dr. Dudley lays the trouble to the blow of the gag in straightening, following delayed transformations of the metal near the center. His findings are in part as follows:

CAUSE OF INTERIOR FISSURES

Induced interior transverse fissures in basic open-hearth rails are due in part to an occasional hot rail being cooled so rapidly by the rolls and their pressures to elongate the bar, or chilled by gusts of air before recalescence on the hot beds, as to cause a lag of some of the transformations of the metal in the interior of the head. Induced interior transverse fissures can develop in the track only from the effects of preceding causes, neither of which is any longer a mystery, and their progressive stages of development occur in the following order:

Conditions of Manufacture.—The first contributory cause is delayed transformations of the metal near the center of the head, and chemical or mechanical defects. The first defect is induced loss of strength, initial strains and physically a nonductile core of heterogeneous metal near the center of the head.

The second contributory cause is mechanical injury to the heterogeneous metal, the nucleus being checked by the gag. The second effect is the produced defect of an interior invisible portion of fractured metal near the center of the head before the rail leaves the steel plant.

Conditions of Service.—The third contributory cause acts when the conditions of ordinary service for the interior fractured metal become abnormal. The third effect is that the checked interior metal is no longer able to restrict the strains of the wheel loads within the usual range of the elastic limits of the steel, as in the case of sound metal, but develops by "detail" growth, from and around the checks, the specular surfaces of the induced interior transverse fissures until the section ruptures.

NO FISSURES IN HOMOGENEOUS METAL

Interior transverse fissures have not occurred in the countless thousands of rail heads of physical homogeneous metal for the reasons that they do not contain the conditions of the first contributory cause, and consequently, while the metal is lengthened or shortened by the second contributory cause, it is not checked.

Doctor Dudley points out that basic open-hearth rails in the composition of the New York Central Lines specifications and rolled from reheated blooms have not, to date, developed interior transverse fissures, and he believes that what he has set forth can be utilized to prevent the conditions arising in the manufacture of rails which tend to induce interior transverse fissures in the output.

Literature

For the Civil Engineer and Contractor

New Publications

RAINFALL DATA OF BERKELEY, CALIFORNIA. By William Gardner Reed. University of California Publications in Engineering Nos. 5 and 6. Paper, 7 x 10¾ in.; 13 pages and 34 pages. Berkeley, Cal., University of California Press.

CORRECTION OF ECHOES AND REVERBERATION IN THE AUDITORIUM AT THE UNIVERSITY OF ILLINOIS. By F. R. Watson, associate professor of experimental physics, and J. M. White, supervising architect. Bulletin 87, Engineering Experiment Station. Paper, 6 x 9 in.; 20 pages; illustrated. Urbana, Ill., University of Illinois. 15 cents.

THE SLIDE RULE: A PRACTICAL MANUAL. By C. N. Pickworth, editor of the *Mechanical World*. Fourteenth edition. Cloth, 5 x 7¼ in.; 124 pages; illustrated. New York, D. Van Nostrand Company. $1 net.

This edition of a very complete and helpful descriptive and theoretical work on the slide rule has been revised and the contents extended to include the solution of algebraic equations by slide rule.

LECTURES ON TEN BRITISH MATHEMATICIANS OF THE NINETEENTH CENTURY. By Alexander Macfarlane. Mathematical Monograph No. 17 of series edited by Mansfield Merriman and Robert S. Woodward. Cloth, 6 x 9 in.; 148 pages; illustrated. New York, John Wiley & Sons, Inc. $1.25 net.

These lectures on pure mathematicians of England were delivered at Lehigh University during the years 1901 to 1904 inclusive, and abound in lively personal reminiscences of distinguished men whose work was accomplished during the middle of the last century.

AUTOMOBILE HANDBOOK. By J. E. Homans. Cloth, 5 x 7½ in.; 248 pages; illustrated. New York, Sully & Kleinteich. $1 net.

Full description of essential parts and auxiliaries, with directions for rearrangement, operation and care of the gasoline motor car.

WHY HIGHLY OXIDIZED RED LEAD IS SUPERIOR. By G. W. Thompson, chief chemist, National Lead Company. Paper, 6 x 9 in.; 9 pages. New York, National Lead Company.

THE PHYSICO-CHEMICAL PROPERTIES OF STEEL. By C. A. Edwards, professor of metallurgy, Manchester University. Cloth, 6 x 9 in.; 229 pages; illustrated. Philadelphia, J. B. Lippincott Company; London, Charles Griffin & Company, Limited.

HOW TO BUILD UP FURNACE EFFICIENCY. By Jos. W. Hays, combustion engineer. Tenth edition, revised and enlarged. Paper, 5 x 7½ in.; 154 pages; illustrated. Chicago, Rogers Park, Jos. W. Hays, publisher. $1 net.

REPORT OF THE RECLAMATION BOARD OF CALIFORNIA, 1916. Paper, 5¼ x 9 in.; 36 pages and 2 maps. California, State Printing Office.

A report of the board's activities in flood control on the Sacramento and San Joaquin rivers up to April 1, 1916, with suggestions relative to the work in hand. It reviews the work done under the powers conferred by the Reclamation Board Act, by virtue of which the board directs private reclamation, and covers the extensive work which has been done on the projects now being carried out in the central California valleys. Tables are given to show mileage of river and bypass levees proposed, constructed or in process of construction.

Books Reviewed

Structural Timber Handbook on Pacific Coast Woods

Author, O. P. M. Goss, assisted by Carl Heinmiller. Flexible leather; 5 x 8 in.: 289 pages; illustrated. Seattle, Wash., West Coast Lumbermen's Association. $1.

Several very valuable and unique features in the principal tables of this book make it of unusual interest to designing engineers. For example, Table 20, covering 144 pages, contains the safe uniform loads permissible for surfaced rectangular beams, the actual sizes of which are given, the deflections, the pounds carried per foot board measure, and the horizontal shear for various span lengths of beams for nominal sizes from 2 x 4 in. up to 20 x 30 in. Nine different fiber stresses from 1000 up to 2000 lb. per square inch are included. Especially noteworthy is the fact that actual surfaced sizes are used in computing these values. Factors (greater than unity, with a maximum of 1.5) are given by which, if desired, the values can be multiplied to give loads, deflections, etc., for full-size rough timber. Another notable feature is the load per foot board measure presented in this table. It makes possible a quick comparison of the relative economy of various possible beams for a given load and span.

Among other points of unusual value may be mentioned the reports of recent tests of Douglas fir and other Western timbers, with a structural Douglas-fir specification for bridge and trestle timbers; the diagrams and figures for cost of timber and brick mill buildings; data on creosoting of Douglas fir; tables of safe loads on surfaced columns and on surfaced beams governed by shearing strength, and the maximum spans and deflections for mill and laminated floors.

The tables and diagrams are exceptionally well devised, with excellent typographical work throughout. The book should prove of value to all engineers who are concerned with timber design of any kind.

The Practical Design of Steel-Framed Sheds

Author, Albert S. Spencer. Cloth, 6 x 10 in.; 163 pages; illustrated. New York, D. Van Nostrand Company. $3.50 net.

REVIEWED BY F. H. CONSTANT

Professor of Civil Engineering, Princeton University, Princeton, N. J.

This book is intended as a practical guide to the design of steel mill buildings with column supports. It does not enter at any length upon the theory of truss and column stresses, or the design of individual members, a knowledge of which is presumed of the reader; but it consists mainly of tables giving total stresses and required sections for all parts of the several kinds of buildings treated and for the ordinary range of spans. It is expected that by the use of these tables the designer will be able, with little labor, to pick out all the sections needed for a given structure.

The various types of sheds (transverse bents) are classified according to the degree of fixity of the ends of the columns. Types 1 and 2 have no kneebraces; in the former both ends of the columns are assumed as pin points; in the latter the base is considered fixed to an adequate concrete pedestal. Types 3 and 4 have kneebraces, the former being assumed pin-jointed at cap and base, the latter only at the top, the base being considered fixed. Type 1, being unstable and unsuitable, receives no further consideration.

The first chapter pertains to the resistance to wind forces. The system of nomenclature and the stress formulas are given, and the latter are applied in the calculations of numerical examples carried out to the actual sections of the various parts of the structure and foundations.

In explanation of the plan of the book the author states that "by adopting a constant outline for the principal members of the roof frames, by using a constant relative proportion for the main dimensions, and also a similar combination of data, stress coefficients may be obtained, which, when multiplied by certain necessary varying factors, will give the total stresses in the various members. Further, by the compiling of a standard table of sections for sheds of varying dimensions, the manufacture will be accelerated and cheapened." This plan for the "standardizing of shed members" is carried out by the insertion of some hundred pages of tables of stresses and standard sections, with sufficient explanatory text to make the meaning and use of the tables clear.

Doubtless the book will be of considerable service to English designers. Differences in American and English practice, and the existence of so many excellent American books on mill-building construction, will greatly lessen its value in this country. A published set of similar tables (such as exist in the offices of many bridge companies) accurately representing American practice would probably be welcomed by American constructors.

The last two chapters are descriptive of coverings, gutters, pipes, ventilators, etc. There are twelve folding plates, devoted mainly to stress diagrams and tables of stresses and sections for different types and spans of transverse roof frames and details of construction.

Hydraulic Flow Reviewed

Author, Alfred A. Barnes. Cloth, 6¼ x 9½ in.; 158 pages; 11 folding plates. New York, Spon & Chamberlain. $4.50.

REVIEWED BY A. G. HILLBERG
Hydraulic Engineer, New York City

In this volume the author presents his investigations regarding the laws for the accurate measurement of water in either large or small quantities. New formulas have been developed and when compared with discharges ranging from 0.0034 sec.-ft., as measured by orifices, up to 320 sec.-ft., as determined by weirs, they have proved correct within a remarkably low percentage of error.

The formulas are all of the same type; that is, $v = Km^{\alpha}H^{\beta}$, which, for pipes and channels, by means of the introduction of the length in the direction of flow, becomes $v = Km^{\alpha}i^{\beta}$, where v is the velocity; m the hydraulic radius (called by the author "hydraulic mean depth," which might possibly be confused with mean depth or area divided by width); H, the head; i, for pipes, the head lost divided by the length of pipe, and for channels, the sine of the angle of inclination, and K, α and β, constants to be determined by experiments.

After a brief introduction and discussion of the formulas developed by Chezy, Prony, Darcy, Ganguillet and Kutter, Bazin, and Barre de St. Venant, the author explains the advantages gained by using logarithmic plotting of experimental data, and uses these advantages as proof of the superiority of the exponential form of hydraulic formulas. Having written the general formula, the author, by introducing values and conditions making $v = k$, states that "in a general way it can be stated that $1/K$ in each case represents a measure of the relative surface friction per square foot."

A list of formulas for the flow of water in pipes, channels, canals and rivers is given. Not less than sixteen different sets of coefficients are required to provide for the differing influence of the condition of the contact surfaces, and including allowances for deterioration in each type of channel. This table is followed by sixteen others, each comparing the formulas with experimental data, including various kinds of pipe, conduit and channel. The wealth of experimental data given in these tables is enormous, not less than 3162 separate experiments being quoted and the experimental data classified.

The second part of the book deals with the measurement of water by triangular notches, weirs and circular orifices. The author proves that by using his formula with the proper constants and exponents the commonly used varying coefficient will be abolished for conditions where the velocities are greater than the critical. As the critical velocities are very small and rarely met with in practice, engineers will not be inconvenienced because of this discrepancy of the formulas.

The author should be complimented for the thorough manner in which he has dealt with the subject, and it is believed that the new formulas developed will be appreciated and used extensively by the engineering profession.

Cambria Steel Handbook

Author, George E. Thackray, special engineer, Cambria Steel Company. Eleventh edition. Flexible leather, 4¼ x 6½ in.; 513 pages; illustrated. Philadelphia, Cambria Steel Company. $1.25.

This edition—the eleventh—of the well-known Cambria handbook brings up to date the practice of this company and includes some additions to, and also a few opinions of, matter appearing in the tenth edition. Among the new sections of structural steel are heavier rolled 24-in. I-beams weighing 105, 110 and 115 lb. per foot. Tables are supplied for the properties of all the new sections. A useful amplification of the table giving properties of steel rails is made to include other recently adopted standard sections and the revised values for section moduli.

More than fifty sections of built-up plate girders have been added to the valuable table giving safe loads and weight per foot for such girders. The table of standard pipe has been increased in size by the inclusion of properties, and the tables of extracts from building laws now embrace thirty-one cities. The new revised Manufacturers' Standard Specifications for structural and boiler steel (dated April 21, 1914) are reproduced, and replace the older specifications.

It is interesting to note the great increase in maximum length and thickness of sheared plates scheduled in the latest edition compared with the limits given in the sixth, or 1904, edition. The maximum thickness is increased from 1½ in. to 2 in., and although the maximum width is increased only 1 in., from 125 in. to 126 in., the width of plates of given thickness has been largely increased. For example, ⅜-in. plates are now listed 125 in. wide instead of 113 in. The limiting length for all the thinner plates is extended in many cases to nearly double the old limits.

Those engineers who are familiar with this useful handbook will find its latest form as satisfactory as ever, with its value much enhanced by the new material.

Letters to the Editor

Comment on matters of interest to engineers and contractors will be welcomed

Abandoned Bridge Difficult to Destroy

SIR: It was with much interest that the writer read the article and studied the illustrations therein, pertaining to the destruction of a reinforced-concrete beam-and-slab bridge at Memphis, Tenn., to make room for a new levee ("Abandoned Bridge Difficult to Destroy," page 132, July 29, 1916).

The way the structure resisted efforts to destroy it is truly remarkable, in view of the fact that the reinforcement of columns and beams was not what could be called good practice. Had the column bars been stayed with hoops or spirals and some stirrups provided in the beams, and longitudinal distributing bars in slab as current practice dictates, it is safe to say that the work of demolition would have been much more difficult.

Photographs 10 and 11 are of special interest, since they show clearly the result of reinforcing and pouring the slab and beams as separate units. In this particular structure no doubt the beams were designed as rectangular sections below and independent of the slab (the location of the top reinforcement in illustration 10 indicates this); but in more than one case of which the writer has data contractors have or have endeavored to pour the beams to the under side of the slab one day and the slab the next (just as was probably done in this particular case), even though the beams were designed as T-beams, which necessitated a monolithic construction of beam and slab in order to obtain the action assumed in design. This would seem to indicate that it is highly essential to state very plainly on detail construction plans that in T-beam construction the slab shall be poured integral with the beams. This at once settles the question of method of design and gives the contractor no recourse, if the inspector attends to his business, except to carry out the intentions of the designer.

Had stirrups been used in the beams with tops anchored in the slab, and had the bent bars in the beams been carried up into the slab, instead of being placed just under the slab, and the slabs and beams poured at one time, no such marked lines of cleavage and separation of slab and beam as indicated in photographs 10 and 11 would have taken place. Other failures and buildings damaged by fire have developed these same faults; and in the writer's opinion, no better or more forceful arguments can be presented to the lax or careless designer than these fruits of the folly of his kind, and more good can be accomplished by their prominent display than by volumes of textbooks. Such is one of the duties of the technical press, an important part of its valuable educational work.

The lack of longitudinal reinforcement in slab, as shown by breaks over one of the columns, reminds one of the failure of the Meriden Street bridge at Indianapolis during the floods of the spring of 1913, where on account of lack of sufficient transverse reinforcement a series of arches split in half longitudinally after the piers had been undermined, one section dropping into the river, while the other remained in place. Some designers fail to appreciate that placing bars in one direction only in concrete work does not adequately reinforce it against temperature and other unforeseen stresses, and thereby prevents it from withstanding sudden and unexpected tests.

It would be interesting to know whether the columns in this Memphis bridge, which failed by pushing out at the bottom, were tied to the footings by dowels or simply rested upon them without connection other than the bond between concrete of the footings and columns. Since by proper design a concrete structure can be made to act as a monolithic frame, thereby greatly increasing its strength, especially in so far as the resistance of unusual loads is concerned, it seems like a rather shortsighted policy to erect concrete like so many blocks of stone masonry. Why not make use of every bit of the latent strength of concrete at critical times by considering something besides mere load-carrying capacity in design?

ALBERT M. WOLF,
Chicago. Assoc. M. Am. Soc. C. E.

Justice to the Contractor

SIR: Commenting on H. G. Shirley's letter entitled "Justice to the Contractor" in the Aug. 5 issue of your paper, page 180, I heartily agree with Mr. Shirley that specifications should be clear and definite and that the engineer or his authorized representative in charge of work should be a man of good judgment and experience, or, as quoted, have "horse sense." Then there would be no need for a board of arbitrators to settle matters in dispute.

I think the reason why so many contractors raise questions and have disputes as to their rights is because in a good many cases a young and inexperienced engineer or inspector is put in actual charge of work. It may be unimportant work, and when a question is to be and should be decided then and there, on the job, the inexperienced engineer feels that he cannot assume the responsibility of varying in the slightest degree from the ironbound specifications, while really he need not vary, but only use a little common sense. On the other hand, we cannot always wholly blame the inexperienced man in charge, when he has been given instructions by his superiors to make the contractors live up to the letter of the specifications regardless of circumstances and constructions.

Specifications are not written for deception and dispute, nor to stand as infallible, but to define in clear and definite terms the scope and class of work to be performed, and should be carried out jointly by the contractor and engineer, working together in harmony, instead of each trying to "do" the other.

Why cannot competent and experienced men be selected to have charge of work and not schoolboys to interpret specifications and direct the work for experienced contractors? The mere ability to give lines and grades correctly does not necessarily mean that a man is competent or suited for the work. He must be a man of good discretion also, so that both contractor and engineer can feel that the work must be carried out with equity and fairness for both sides.

Having been on "both sides of the fence," I feel that too little attention has been given in selecting men for responsible positions of this kind.

What seems to be needed most is "horse sense" specifications, "horse sense" men in charge of the work and a desire to "pull together." R. M. STAMPER,
Philadelphia. Civil Engineer.

Plumbers or Sanitary Engineers?

SIR: I have just read with interest the editorial in your issue of Aug. 5, page 157, regarding the action of the plumbers of Indiana banding themselves into an organization called "Sanitary Engineers." I most heartily concur with your statements regarding the grave necessity for representative engineering societies taking up the cudgels in favor of the correct application of the term engineering and of the title engineer. It most assuredly seems that our engineering societies are far from awake, in so far as any concerted effort to check this widespread misuse of the term engineer is concerned; but on the other hand, do you not think—in all fairness—that the plumbers of Indiana are not entirely to blame for their presumptive action?

To substantiate my belief in their innocence I would refer you to page 48 of the Engineering Record of Aug. 5, where there appears under the heading "Positions Vacant" the following advertisement: "Hoisting engineer wanted. We would like to have Charlie Nichols and Dick Riley or any other first-class three-drum hoisting engineer who worked at Nicholson in 1913 on the cutoff communicate with us, as we have a position open for a hoisting engineer; steady work."

After reading the foregoing it is not difficult to understand what the advertisement is calling for; but do you not think that this is one of the most unique branches or departments of engineering yet advertised before the eyes of an observant public? To me it seems that the plumbers of Indiana have quite as much right to the title engineer as a man operating a crane or a hoist. From the standpoint of general education and culture, I believe the plumbers would, individually, quite outdistance the type of man called for in your advertisement.

Now, do you not consider it necessary for engineering periodicals to offer some assistance to the very urgent efforts to improve the proper use of the term engineer by placing in print only reading matter that will aid toward a realization of this improvement? It seems logical to me that unless engineers, and particularly our representative engineering periodicals like the Engineering Record, set an example to the world, we can hardly blame plumbers, locomotive drivers, janitors of apartment houses and other individuals equally as remote in their labors from true engineering when they usurp the title engineer.

N. T. BINKS,
Civil Engineer.
Shawinigan Falls, Quebec.

[At first blush it might seem that the Engineering Record stands convicted. Be it remembered, however, that this journal is for civil engineers and contractors, in the field to supply the wants of both classes. Ancient custom has fixed upon the man who runs a hoisting engine the title of hoisting engineer. Civil engineers may resent this; it is suspected that some hoisting engineers, gazing upon young manipulators of tape and plumb-bob, also resent it. Yet few readers of the Engineering Record will confuse the hoisting engineer, as such, with the civil engineer. And in the present state of the art when a contractor is enough in need of a hoisting-engine operator to advertise for one there seems to be no better way than to let him designate that personage just what everybody else does—a hoisting engineer.—EDITOR.]

Test Concrete Cured Under Freezing Conditions

SIR: I have noticed the article in the July 15 issue of the Engineering Record, page 78, on "Test Concrete Cured Under Freezing Conditions." This article contains some interesting and valuable information which should be noted by builders, engineers, and others interested in concrete and reinforced-concrete construction work.

A similar series of tests was carried on by the writer during the last three years at the University of Illinois, and part of the results are embodied in Bulletin 81 of the Engineering Experiment Station. During the past year the writer has conducted a series of tests to determine the effect of alternate freezing and thawing upon the strength of concrete. It is not possible to make known the results at this time, but in a general way the data demonstrated the necessity of allowing concrete to set under a normal temperature before subjecting it to freezing conditions. The duration of the initial set under normal temperature conditions to prevent later disintegration under freezing and thawing conditions was found to depend upon the setting quality of the cement and the proportions of the concrete mixture.

The results of tests and experience still confirm the writer's original opinion that in concrete construction under freezing-temperature conditions the concrete must be maintained at a temperature of not less than 40 deg. Fahr. for not less than 48 hours after placing.

West Baldwin, Me. A. B. MCDANIEL.

Coal Mined in 1915

The production of bituminous coal and anthracite in the United States in 1915 amounted to 531,619,487 short tons, valued at $686,691,186, an increase, compared with 1914, of 18,094,010 tons, or 3.5 per cent, in quantity, and of $5,200,543, or 0.8 per cent, in value, according to C. E. Lesher, of the United States Geological Survey. Of this total output, 442,624,426 short tons, valued at $502,037,688, was bituminous coal and lignite, and 88,995,061 tons, valued at $184,653,498, was Pennsylvania anthracite. Pennsylvania, with an output of 157,955,137 tons of bituminous coal and 88,995,061 short tons of anthracite, ranks first among the coal-producing states. West Virginia, with a production of 77,184,069 tons; Illinois, with 58,829,576 tons; Ohio, with 22,434,691 tons; and Kentucky, with 21,361,674 tons, follow in order of production. Thirty states and the Territory of Alaska contributed to the total.

HINTS FOR THE CONTRACTOR

Details Which Save Time and Labor on Construction Work

Other articles in this issue of interest to contractors and construction engineers are indexed in the Table of Contents

[*Contributions to this section are solicited, and if found available will be paid for. They must be* SHORT, *and should be accompanied, if possible, by photographs or sketches.*—EDITOR.]

Automatic Hoist Stop Saves Extra Man on Crew

IN handling the muck from the Twin Peaks tunnel in San Francisco it has been found economical to control the operation of the hoisting motor by an automatic stop so that there is no necessity for having a man on the payroll whose primary duty is to operate the hoist. The illustration shows the general arrangement of the hoist which brings cars from the floor of the tunnel to surface tracks or to bunkers which load by gravity into motor trucks.

The mule driver who delivers the loaded dump car onto the elevator at the level of the tunnel floor throws a switch which starts the 25-hp. motor operating the hoisting winch. By means of a three-way pushbutton control he sets the mechanism so that the elevator stops automatically at the desired level. When the empty car is ready to be returned to the tunnel the attendant who handles the cars at the top simply trips the mechanism set for tunnel level. This is controlled to a nicety by a projection clamped to the cable, which trips a switch at proper height. It has been possible to regulate this, it is stated, so that the rails of the elevator meet the stationary track accurately enough to allow the car to be trundled off without delay.

CONTROL OF THIS HOIST IS AUTOMATIC

The total lift is about 50 ft., at which elevation the muck is dumped into bunkers. Timber and other supplies going into and out of the tunnel are handled by means of the tracks at surface level. The capacity of the dump cars used is 2 yd. loose, or 1¼ yd. in place. The average quantity handled by the hoist is 90 cu. yd. per 8-hour shift, or 327 cu. yd. loose per day.

The contract on the work is held by R. C. Storrie & Company. M. M. O'Shaughnessy is city engineer.

Derrick Boats Used Inside Coffer Without Extra Digging

THE SCOUR of the Ohio River, confined in a half-width channel between the completed lock and the coffer inclosing the bear trap weirs during the construction of government dam No. 12 at Warwood, W. Va., eroded the river bed to a depth of 26 ft. While this increased the expense of cofferdam building, it afforded an excellent opportunity to use the derrick boats inside the coffer for completing the closing section of the navigable pass next the bear traps. The foundation for this section of the movable dam is on piles. Above it is driven to rock a cutoff wall of wood sheeting, and below it a long 20-ft. wide crib of 10 x 12-in. timber is sunk almost to rock and filled with riprap. A mixer boat equipped with a 78-ft. tower (described on page 89 of the Engineering Record for Jan. 16, 1915) was able to spout the concrete from outside the upper arm, so that the greater part of the derrick work to be done consisted of building, sinking and filling the crib, and handling reinforcing, oak sills and castings for the foundation.

TAKE ADVANTAGE OF DIGGING DONE BY RIVER TO USE DERRICK BOATS INSIDE COFFER

Because of the deep scour, no dredging was needed to float the derrick boats below the line of the crib with the foundation unwatered. The lower arm of the coffer was, however, built 100 ft. below the pass, leaving a space below the channel for the boats into which every yard of excavation was put without rehandling. Because of the economy in spouting concrete direct to the forms, however, the upper arm was built as close in as possible, leaving no room above the foundation for a boat.

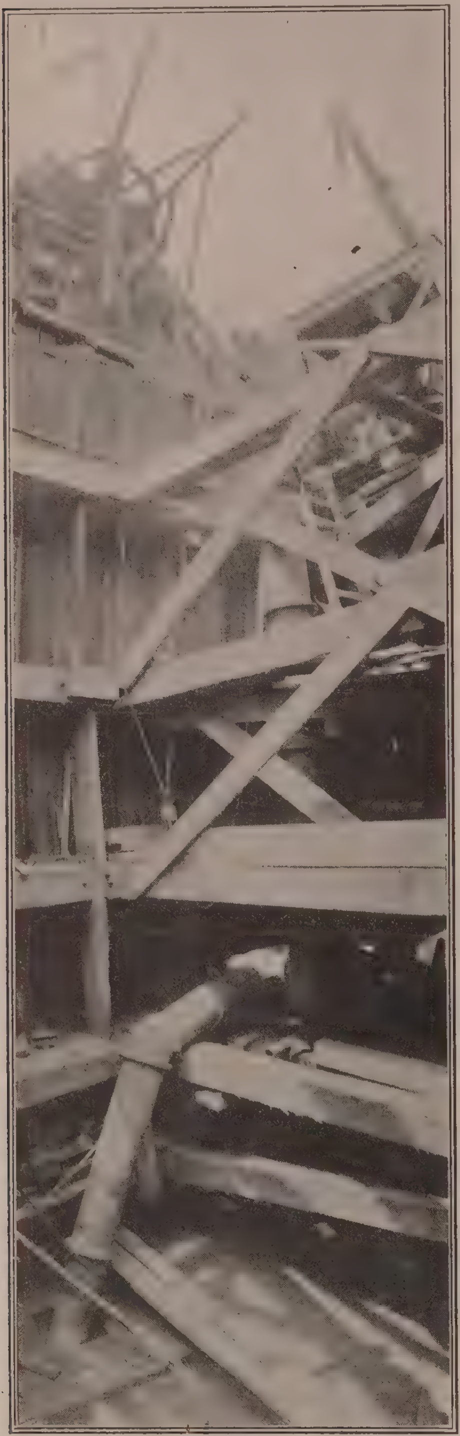
The sheet piles were driven by a land driver, and the round piles by a carriage driver rolling forward on the sheeting and the crib and sidewise on the base of the carriage. The cribs were built and sunk and forms, sills, reinforcing and castings set by the derrick boats. The reinforcing was delivered by barge in bundles and carried on the decks of the derrick boats. These boats maneuver with considerable speed by casting out the loaded bucket and pulling forward, backing or turning by keeping a strain on the bucket lines and manipulating the boom. The two of them inclosed in the coffer covered every part of the 350-ft. section, and were busy at productive work practically 24 hours a day.

The only part of the work they could not reach was a 10-ft. wide strip of 4-ft. riprap laid along the upstream edge of the foundation. On the Monday morning after the concrete was finished the riggers began to set up a small traveler derrick on the east end of the 350-ft. section of foundation. The following Saturday night they had finished taking this traveler down at the west end next the first bear-trap pier. Meantime it had set the 600 cu. yd. of rip-rap.

The entire section of pass foundation, resting on 560 round piles and requiring 2250 yd. of concrete, 5300 yd. of riprap and 250,000 ft. b.m. of crib timbers, was completed in 40 days after pumping out the coffer. The work, done by the Foundation Company, was at the time in charge of F. W. Adgate, western manager.

Centrifugal Pumps in Tandem Raise Water 68 Feet

TWO 12-in. centrifugal pumps, the suction of the upper one connected to the discharge of the lower one, are being used to unwater an 36 x 110-ft. steel cofferdam 65 ft. deep for the condenser pit of the new American Gas & Electric Company's station on the Ohio River near Wellsburg, W. Va. The two Morris pumps used in this way are intended for low heads, and either alone would raise water economically only 40 ft. Water hammer was overcome by taking off the foot valve, and surge trouble was corrected by slowing down both pumps.



NEW WAY TO "HOOK UP" CENTRIFUGALS

The station is being built by the Foundation Company under its Wheeling district office, of which George R. Johnson is in charge. The pumps described were set up by W. Tuttle, master mechanic.

Double Motor-Driven Brushes Clean Reinforcing Cheaply

By HAROLD E. KETCHUM

Superintendent, Hunkin-Conkey Construction Company, Cleveland, Ohio

THE BRUSH CLEANER shown in the photograph is removing rust from the reinforcing bars used in the Detroit-Superior high level bridge in Cleveland at a labor cost of 50 cents a ton. It was built at the job. The two brushes are belt-driven from a countershaft by a 3-hp. electric motor, and the steel is fed either between them or across the tops of both brushes. Two or three laborers are employed, the bars being cleaned just before they are bent and used. The bridge is being built by the Hunkin-Conkey Construction Company.

REINFORCING BARS ARE FED ACROSS THE TOPS OF THE BRUSHES OVER THE WOOD RACKS

Card Index Handy for Checking Prices on Small Items

By BENJAMIN L. LATHROP

Of Lathrop, Shea & Henwood Company, Scranton, Pa.

A PRICE LIST which combines the advantages of ready accessibility, easy elimination of dead matter and quick discovery of any change in price can be kept on 3 x 5-in. cards made out and indexed in the form illustrated. All items should be indexed after the initial letter of the descriptive noun. For example, rocker arms appear after the index card A.

ARMS	
Rocker arm and pin No. ——, Bucyrus Co., Jan. 14, 1914,	$3.50
Rocker arm for Loco. No. 2248, Vulcan Iron Works, Dec. 31, 1914,	10.50

BOLTS		
Stay-bolts, ⅞"x6", Utica Boiler Works, 11/30/10—	each	.30
Machine-bolts ½"x8", Hendrick Co. 7/28/11—	each	.03

A bill comes in for piston rings for a certain engine, charged at $1.25 each. The bookkeeper or his assistant finds the card "rings" and finds that the last time piston rings of this type were bought they cost only $1.10. No notice of an advance in price having been received from the manufacturers, a letter of inquiry is sent which brings either a corrected invoice or an explanation of the increase.

A busy contractor may complain that his bookkeeper has no time to keep an elaborate check on prices, but the cheapest kind of office help can run a card price list and compare every item with it. A busy office will save the salary of a young man or girl to do nothing else, and in offices where the force is not overloaded with work there is always some one whose spare time can be profitably spent checking prices.

Unwarranted fluctuations occur most often in the prices of little things like bolts, repair parts, and tool handles, though occasionally an error will be found in billing carload lots of material like cement or coal. The little things, however, mount up, and the saving to be effected by watching them will surprise anyone who has not kept a careful check on prices.

The moral effect on a dealer who receives two or three complaints of overcharge is also considerable. He will be careful to see that the offense is not repeated, and that, when possible, advance notice of price changes is sent to the customer so that he may cover his immediate needs under a contract.

Government Dredger Makes Trip from Baltimore to San Francisco

The United States hydraulic suction dredger San Pablo, after a 34-day trip from Baltimore via the Panama Canal, arrived at San Francisco recently. The dredger, which is to be used to deepen the channel from San Pablo Bay to the Mare Island Navy Yard, was built at Skinner's shipyards, Baltimore, at an approximate cost of $300,000. It is 155 ft. long and has a beam of 65 ft. and a gross tonnage of 834. According to tests made on completion, this dredger has a capacity of 500 cu. yd. in 28 minutes.

NEWS OF THE WEEK

Passing Events in the Civil Engineering and Contracting Fields

To Place Central Span of Quebec Bridge

5000-Ton Truss to Be Raised to Place from Six Pontoons by Means of Suspender Bars During Second Week of September

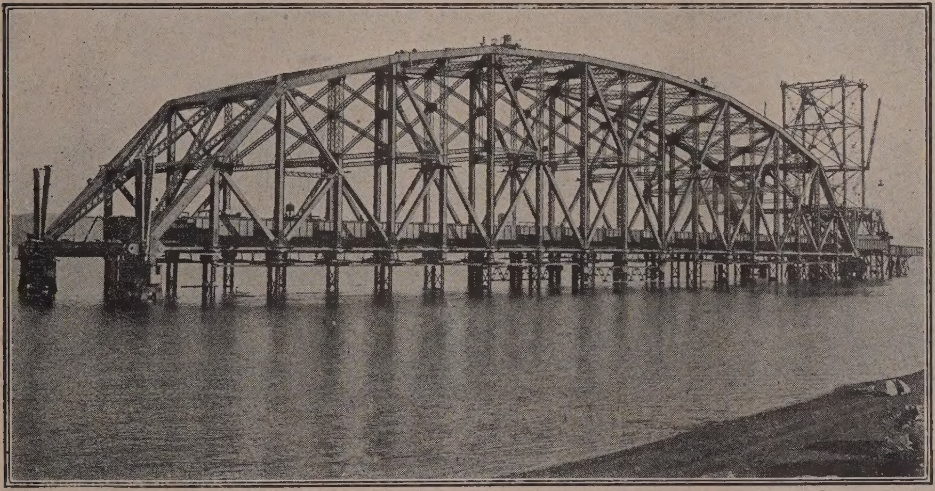
The central span of the Quebec Bridge will be placed, according to present expectations, during the second week in September by floating the span at high tide beneath the gap between the ends of the cantilever arms and attaching to its corners suspender bars by means of which the span will be jacked up in short lifts. Eight 1000-ton jacks, two at each corner, will be used, and the span will be guided during its ascent by two hanging trusses, shown already erected in one of the photographs.

All the main members of the structure have been completely erected and work is now being rushed on the installation of mechanical equipment required for placing the center span. This span is a structure 640 ft. long, 110 ft. high at the center and 88 ft. wide. It will weigh in the condition in which it will be lifted to place more than 5000 tons. It has been erected at Sillery Cove, 3 miles below the site of the bridge, and will be floated to place on six large pontoons constructed for the purpose, three being used under each end. Long steel links suspended from the four corners of the cantilever arms will be connected by means of pins to the floating span at the extreme flood tide, when the current will be least. As the tide recedes the pontoons will fall away from the superstructure, leaving it suspended. The jacks will then be brought into play and the span slowly lifted to its proper elevation and coupled up. The whole operation, if everything works smoothly, should not require more than 24 hours.

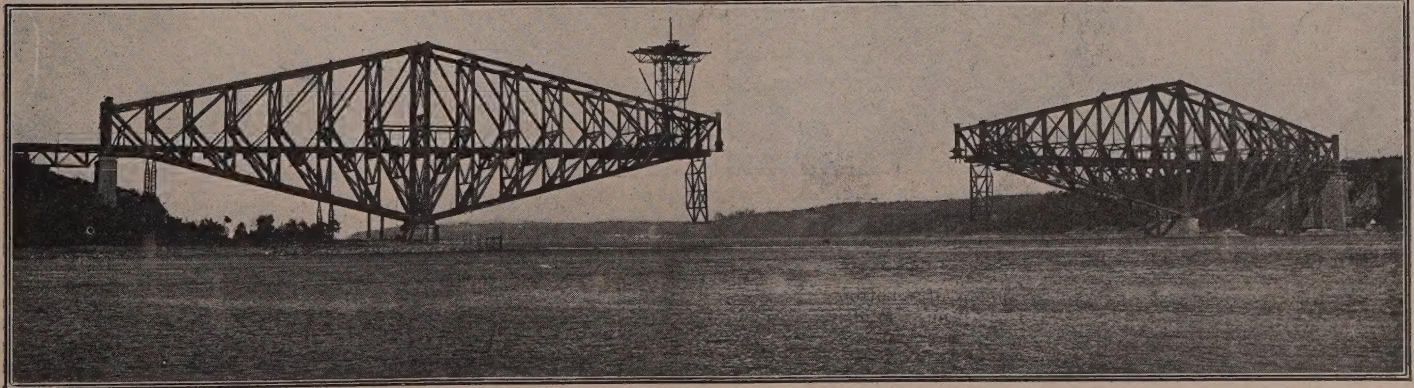
The actual day on which the floating will take place cannot be decided upon until the time arrives. A 12 to 16-ft. tidal range, producing currents of 6 to 8 miles at the bridge, materially increases the difficulties involved, and a quiet day with practically a complete absence of wind will be absolutely necessary.

Observations of the weather have been carried on with considerable elaboration during the past two years, and records have been prepared showing the probabilities at this season. A wireless storm detector has been installed at the bridge site and records of this have been taken for the past year. This indicator will show the approach of an electrical storm about six hours before it arrives. The bridge will also be kept in close touch with the meteorological observatories in Toronto and Quebec, so that all data will be available as soon as they are obtained.

High tide during the proposed period of floating occurs between 4 and 5 o'clock in the morning. This early hour is chosen in order to give a long day for the operation. Excursion boats and all traffic in the river will be kept at a distance from the work to avoid all chance of their interfering with the operation. More definite information regarding the date and facilities for viewing the placing of the span will be published later.



CENTRAL SPAN, 640 FT. LONG AND WEIGHING MORE THAN 5000 TONS, READY TO PLACE



MAIN TRUSSFS OF QUEBEC BRIDGE STAND READY TO LIFT SUSPENDED SPAN TO FINAL POSITJON FROM SIX PONTOONS THAT WILL FLOAT IT TO SITE

Undermined by Seepage Flow, Lake Toxaway Dam Fails

Earth Structure in North Carolina, 430 Feet Long and 60 Feet High, Washed Out Following Severe Rainfall

By W. N. WILLIS
Civil Engineer, Spartanburg, S. C.

Undermined by water flowing through fissures in the rock foundation upon which it was built, the earth dam, 430 ft. long and 60 ft. in maximum height, built in 1902 at a cost of $32,000 to form Lake Toxaway, the well-known North Carolina summer resort, was washed out at 7 p. m. Aug. 13. The lake, although created primarily as a tourist resort and for fishing and boating, served also as a storage reservoir at the head of the Toxaway River.

Unprecedented Rainfall

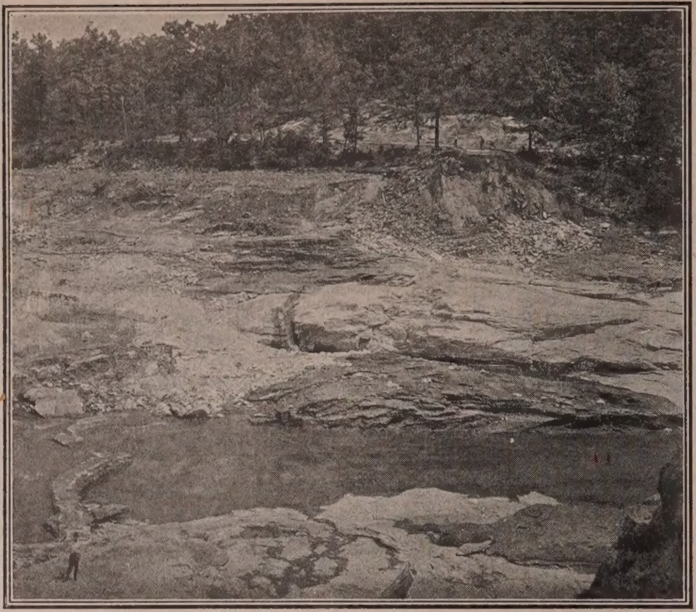
The failure followed a period of unprecedented rainfall in July. Official records at Highlands and Rock House, about 10 miles to the west and near the headwaters, were 17 and 19 in. in 48 hr. on July 8 and 9. This was the same storm which did so much damage along the Gulf Coast and in the Mississippi Valley. It raised the level of the lake about 4 ft. On July 16, with water about 18 in. above normal, another storm from the east, which did so much damage in western North Carolina, raised the lake to 3½ ft. above normal, thus holding the waters of the lake considerably above their ordinary level for about two weeks.

The earth dam, measuring 16 ft. across the top and built with 1:1 slopes, was protected in 1912 with stone riprap, and a breakwater was added at a cost of $12,000. A 400-kw. power house, 16 x 38 ft., of brick construction, also was built. It was supplied by a steel pipe line, 20 in. at the intake, reduced to 12 in. at the power house. The spillway and intake were located around a knoll from the main dam in another gap of the hill. The normal flow of the river is 900 ft. per minute.

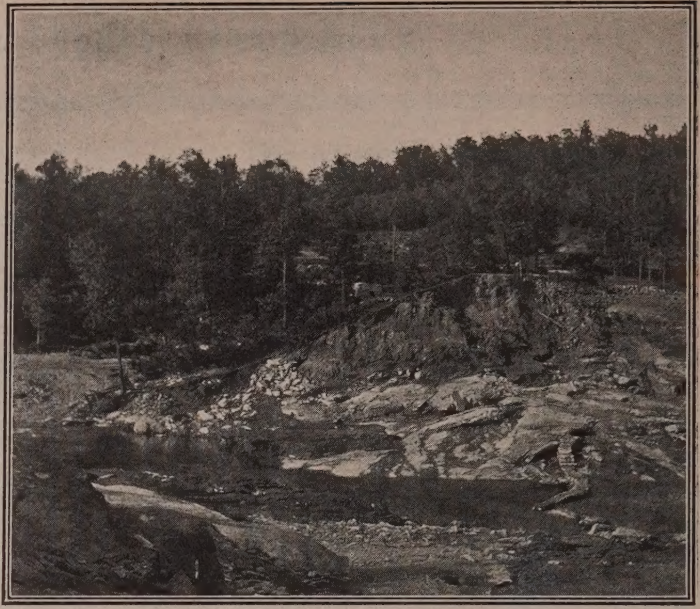
There have always been fears as to the safety of this dam by the people living in the upper part of South Carolina, and soon after the Pacolet flood of 1903 a committee from South Carolina visited this dam, but nothing more was done about it. The water elevation of the lake was 2998 ft., and covered 540 acres with a probable average depth of 20 ft.

The dam had a concrete spillway 20 ft. wide, which was undamaged, with a 3 x 3-ft. gap in the center. It was built under the supervision of T. S. Boswell, engineer of the Toxaway & Brevard Railway and of the Toxaway Company, with J. F. Hayes, of Brevard, N. C., as superintendent.

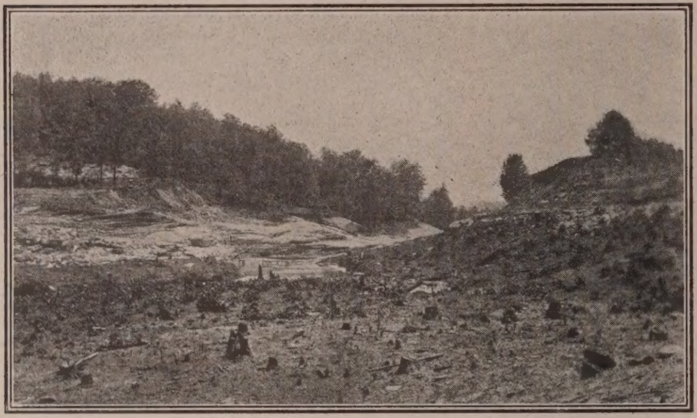
Earth Dam at Lake Toxaway, N. C., Washed Out



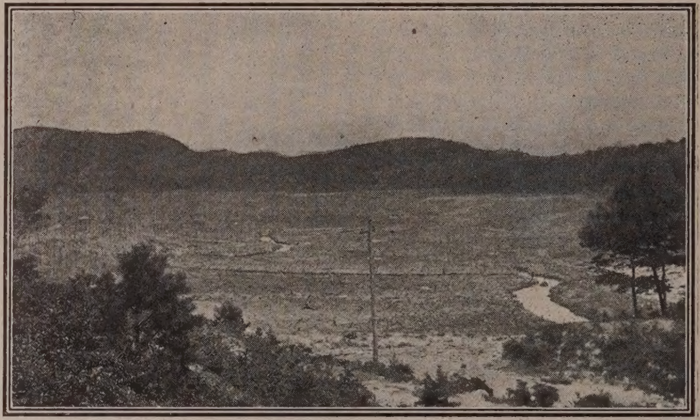
FOUNDATION ROCK EXPOSED BY WASHOUT



PORTION OF EARTH EMBANKMENT REMAINING

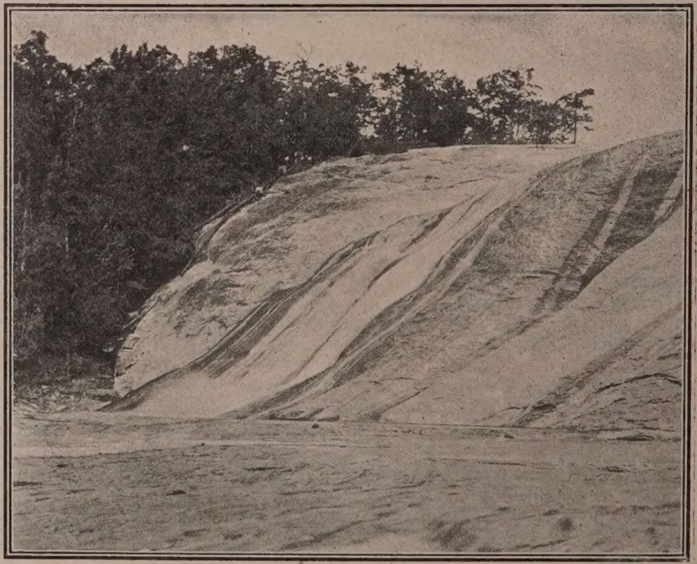


LOOKING DOWNSTREAM AT DAM SITE



LAKE EMPTIED IN ABOUT THREE HOURS

BOATS STRANDED AS WATER RECEDED



WHERE FLOOD SWEPT AWAY POWER HOUSE

About Aug. 5 a small stream or spring of seepage at the foot of the dam, which had been running ever since the dam was built, was noticed to be larger, but remained constant until about noon Aug. 13, when it was noticed to be muddy. About 6.30 p. m. it began caving, and at 7 o'clock the dam started giving away. About 270 ft. in the center went out, draining the lake in from 2 to 3 hr., leaving thousands of game fish on the lake and river bottom. The waters carried out everything to solid rock, except a small section near the stream bed at the bottom of the original dam, which was well compacted. The stone wall built at the upper toe of the dam was not injured.

Just below the dam was situated a wooden county bridge at the head of Toxaway Falls, which are 300 ft. high. The flood at the bottom of the falls was about 75 ft. high, sweeping on through the gorge from 30 to 35 ft. above normal, though only raising the stream about 10 ft. at the mouth of the gorge some 10 or 12 miles below. The power house was completely destroyed, only a few small pieces of metal and wire having been found of the power house or machinery. But very little damage was done to property below on account of the breaking of this dam.

A very bold sulphur spring which, before the break, was located near the lower side of the dam on the left-hand end and about half way up the dam, is now flowing from the opposite side of the hill in the lake bed. Silt and mud are deposited near the edge of the lake where the streams flowed into it, but the main body of the lake bed is free from sediment, with trails and roads as plain as when covered.

This dam appears to have been well built for this type of structure, a channel being blasted in the solid rock and earth packed in to obtain anchorage. The break appears to have been caused by water flowing through seams or fissures in the rock about 5 ft. above and 20 ft. to the left of the creek channel. The increased head in the lake, remaining so long, increased the flow of this stream, causing undermining at this point. The water was never nearer than 5 ft. of the top of the dam.

H. C. Jennings of Philadelphia, owner, states that he does not know as yet whether the dam will be rebuilt or not. The hotel is closed, and most of the owners who have summer homes around the lake have left.

Cleveland Intake Tunnel Being Pushed to Completion

The heading from crib 5, at the outer end of the Cleveland waterworks intake tunnel, which filled with mud for a distance of 287 ft. behind the face at the time of the explosion on July 24, has been practically cleaned out. The last bodies have been recovered, fixing the total number of dead at nineteen. The gas flow, which is just as strong now as at the time of the explosion, is under control and is being carried to the top of crib 5. A good many of the concrete lining blocks were found displaced in the section cleaned out, and some timbering was necessary to get to the heading.

C. P. Jaeger, deputy commissioner in charge of the division of water of the Cleveland Department of Public Utilities, has informed the Engineering Record that there is no truth in the report that it might be necessary to abandon the section of the tunnel in which the explosion occurred. It is planned, if possible, to drive the heading from crib 5 for a distance of 200 or 300 ft. beyond the point where the gas flow was encountered, to avoid the risk of striking the same flow in the heading being driven out from the shore. Work in the latter heading is being prosecuted as usual with three shifts a day, and the gap of 1400 ft. between the two headings—the only section of the 16,000-ft. tunnel yet to be completed—is being closed at a good rate of progress.

Iowa and Illinois Waterworks Men Will Convene in October

The Iowa and Illinois sections of the American Waterworks Association will hold a joint meeting Oct. 10 and 11 at Davenport, Iowa, and Moline and Rock Island, Ill. The business session of the Iowa section at Davenport will occupy the time of the delegates during the first day. Oct. 11 will be spent inspecting the filter plant at Rock Island and the pumping stations at Bettendorf, Iowa, and at Rock Island and Moline, Ill. After the dinner at Moline two illustrated papers will be presented, one by Leonard Metcalf, president of the American Waterworks Association.

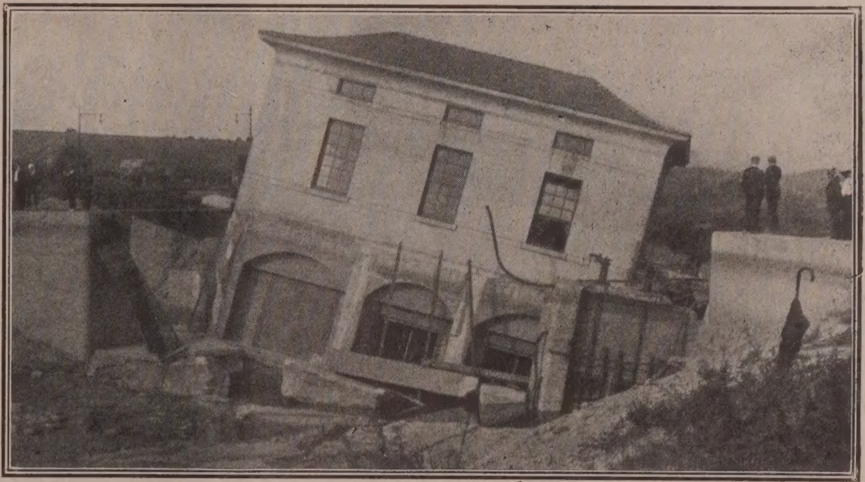
Describes Results of Concrete Tests

Prof. F. E. Giesecke, head of the division of engineering in the bureau of economic geology and technology of the University of Texas, has issued an advance circular in which are described the preliminary results of a series of experiments in the preparation of concrete. The data seem to show that in preparation of concrete it is unwise to mix the ingredients according to some arbitrary proportion. The preliminary results, including a diagram of those obtained thus far in the experiments, as well as the complete bulletin, will be furnished free on application to the University of Texas.

Texas Hurricane Kills Three and Causes $2,000,000 Loss

A severe tropical storm Aug. 18, extending over ten counties surrounding Corpus Christi, Tex., caused the death of thirteen persons and a $2,000,000 loss in crops and property. The wind, said to have reached a velocity of nearly 70 miles per hour, whipped up such a sea that a large pleasure pier at Corpus Christi was demolished. Many smaller structures along the shore were also destroyed. The storm-stricken area extends about 150 miles along the lower Gulf coast, from Corpus Christi to Brownsville, and from 30 to 50 miles inland.

Concrete Structure Falls But Is Undamaged



THOUGH THIS STRUCTURE SLIPPED FROM ITS FOUNDATIONS IT WAS UNDAMAGED

The concrete power house of the hydroelectric plant at lock 29 on the New York Barge Canal at Palmyra slipped from its foundations last month into the position shown. In spite of the unusual stresses which must have been caused by the movement, the structure is undamaged—not even cracked. The machinery, too, is said to be in perfect condition and has been stored in near-by sheds. Quicksand is thought to have caused the failure.

San Francisco-Oakland Bridge Plans Discussed

A public hearing of the proposed San Francisco-Oakland bridge was held in San Francisco Aug. 15 before a board of army engineers made up of Col. Thomas H. Rees, Col. Charles L. Potter and Major George B. Pillsbury, at which bridge plans were considered as follows:

1. By the associated bridge engineers, Wilbur J. Watson & Co., Cleveland; William R. Davis, Albany, N. Y., and Harlan D. Miller, Albany, N. Y., and Oakland, Cal. The bridge is to extend from First and Adeline Streets, Oakland, to Second and Townsend Streets, San Francisco. It is to have 200 and 250-ft. steel spans, with clearances of from 20 to 90 ft., including one bascule or lift span with 200-ft. waterway. The estimated cost, $23,000,900, is to be met by bonding a bridge assessment district made up of San Francisco, Oakland, Alameda, Berkeley and adjacent towns. It is believed that the revenue from the traffic on the bridge would pay for its construction in about twenty-five years.

2. By Charles Evan Fowler, of Seattle. Bridge of cantilever type, to extend from Oakland to Goat Island, with three 2000-ft. spans, 150 ft. high; then to Telegraph Hill, San Francisco, with 2950 ft. of steel spans, including an 800-ft. cantilever span. The estimated cost is $75,000,000, which is to be met by the formation of a private corporation which will build the bridge and take over the transbay transportation systems and charge a 5-cent rate for street car and bridge.

3. By Alan C. Rush, of Los Angeles. Suspension bridge from Alameda shore to Rincon Hill, San Francisco. It is to be 180 ft. high, with spans of 2000 ft. The estimated cost is $32,000,000. It is proposed that Oakland and San Francisco should donate terminals and secure two-thirds of the bridge stock.

At a final hearing held in Oakland Aug. 17 a fourth plan, by Col. Robert A. Lee Van Folkenberg, was presented for a pontoon bridge to cost $19,000,000. A tunnel was advocated by Taggart Aston, modeled after the Detroit tunnel, to cost $15,000,000 for one double tube. Charles F. Reuter offered plans for tubes and terminals at an outlay of $33,000,000, Jerome Newman filed a plan for a trench type of tunnel and John G. Little proposed a low bridge or roadway for the greater part of the distance across the bay, leaving open only a 2000-ft. channel, which could be traversed through a tube.

The data gathered by the army board will be forwarded to Washington for decision by the War Department as to whether a structure could be built which would not be a menace to navigation.

City Will Experiment with Auto Trucks

An 8-ton truck is to be purchased by the city of Cleveland and experiments will be made to compare its efficiency with that of teams of horses. The machine will first be employed in the collection of waste paper and rubbish. If motor trucks are decided upon, it is estimated that about fifty will be required for the street department.

Course in Practical Concrete at Wentworth Institute

Wentworth Institute, Boston, will add to its courses of instruction this fall one on practical concrete, having for its object the training of young men for concrete-construction work. The institute has set aside one of its best laboratory rooms for this course and is fitting it with modern testing machinery and other necessary equipment to make possible various determinations illustrating the technical as well as the practical sides of the applications of concrete.

This work has been made possible largely by the co-operation of the Portland Cement Association, the work having been planned by its extension division. J. C. Donaldson, field engineer of that division, will be located at Wentworth Institute for some time. He will assist in the necessary preliminaries and in starting and directing the course along the lines planned.

Flood in Missouri Carries Away Bridges and Railroad Track

A 4-in. rain at Hannibal, Mo., and a 6.4-in. precipitation at Louisiana, Mo., Aug. 15 transformed the rivers near those cities into miniature torrents. Probably the greatest damage was that in the Salt River and Noix Creek valleys, where bridges of the Chicago, Burlington & Quincy Railroad at Bush, Grassy Creek, Noix and Buffalo were reported washed away. The tracks of the Burlington and the Chicago & Alton Railroad were also damaged.

Highway Superintendents Meet September 14

The New York State Association of County Superintendents of Highways will convene Sept. 14 and 15 in the court house at Syracuse. Road work in New York State will be the topic of discussion at the meetings, which will be held in the mornings only.

Exhibit at New England Waterworks Convention Opens Sept. 12

The committee on exhibits for the thirty-fifth annual convention of the New England Waterworks Convention at Portland, Me., has announced that the exhibit room will be opened Sept. 12 at noon. As the formal opening of the meeting will not be until the following morning, plenty of time is allowed for an inspection of the various displays before the business sessions.

Chemical Industries Will Exhibit Week of September 25

The Second National Exposition of Chemical Industries will be held at the Grand Central Palace, New York City, the week of Sept. 25.

What Engineers and Contractors Are Doing

CLARENCE D. POLLOCK and GEORGE A. TABER have opened consulting engineering offices in the Park Row Building, New York City. The new firm, under the name of Pollock & Taber, will specialize in paving, water-supply, sewerage and sewage-disposal problems. Mr. Pollock has had more than twenty years' experience, partly in charge of paving in New York City, the Borough of Brooklyn, Havana, Cuba, and San Antonio, Tex. He has also studied and practised sewerage design and construction. Mr. Taber has been engaged in water-supply engineering for more than fifteen years, spending several years in that department of New York City and three years as engineer-in-charge of the Croton Aqueduct Commission. In 1912 he was appointed professor of water supply and sewage disposal at the Brooklyn Polytechnic Institute, the duties of which office consist of conducting lectures in the evening. The last three years he has been associated with Nicholas S. Hill, Jr., and S. F. Ferguson. He will retain his connection with the Brooklyn Polytechnic Institute.

E. C. LARUE, United States hydraulic engineer, formerly at Salt Lake City, has been assigned to the special water-power investigation in Oregon.

E. C. MILLER, superintendent of construction for Iliff Brothers, contractors, of London, Ohio, is now directing the erection of concrete arch work on the Pittsburgh, Cincinnati, Chicago & St. Louis Railway, with headquarters at Richmond, Ind.

H. H. BRAUN has resigned as engineer for E. W. Moir, representative of the Ministry of Munitions of Great Britain, to become general superintendent for M. P. and J. T. Davis. He will have charge of building the $5,000,000 government drydocks and shipyard at Quebec. Mr. Braun was graduated from the University of California in 1908, after which he was made superintendent on the construction of the hydroelectric system of the Arizona Power Company. His next work was as construction engineer for the Mexican Light & Power Company. In January, 1910, he was appointed chief engineer for the Mexican division of the U. S. Smelting, Refining & Mining Company, resigning to take charge of building hydroelectric plants for the Ebro Irrigation & Power Company near Barcelona, Spain. For the past year Mr. Braun has been engaged in organization of the munitions supplies for the British Government.

ROSS L. SHREVE has resigned as city engineer of Tillamook City, Ore., because of the increased demands on his time as engineer of Tillamook County.

H. C. BRENT, vice-president of the Fidelity Trust Company, Kansas City, Mo., was recently appointed president of the Keystone Construction Company and of the Salina Northern Railway. The Keystone Company is building the railroad, of which Mr. Brent is now the chief officer.

JOSEPH RIPLEY and MORTIMER G. BARNES, consulting engineers, of Albany, N. Y., have been retained by the Massachusetts Commission on Waterways and Public Lands to report on the construction of the new drydock in Boston harbor. They will pay special attention to the method of cofferdam construction. After graduation from the University of Michigan in 1876 Mr. Ripley entered the service of the U. S. Government as masonry inspector on the Weitzel lock of St. Mary's Falls Canal. He was made assistant engineer in 1879 and placed in charge of improvements on the St. Mary's River. For a year he had charge of the survey of the Birmingham (Ala.) Canal, returning to Michigan as general superintendent of the St. Mary's Falls Canal. He was made a member of the board of consulting engineers of the Panama Canal in 1905 and the following year principal assistant engineer in charge of locks and dams. His appointment as assistant chief engineer in charge of plans for dams, locks and regulating works came in 1907. Mr. Ripley opened consulting offices in Albany in 1911 and is at present a member of the advisory board of engineers on the New York Barge Canal. Mr. Barnes was graduated from the University of Michigan in 1896. His engineering experience acquired before and while attending college was sufficient for him to qualify as masonry inspector on the U. S. ship canal at Sault Ste. Marie, Mich., which position he left late in 1897 to take charge of a survey of the ship canal from Birmingham to the Warrior River in Alabama. He was employed on the Michigan-Illinois canal from 1898 to 1905 and later served on the Panama Canal, leaving that work to practise consulting engineering in New York City. He has been connected with New York State canal work for a number of years.

HUGH M. STRYKER was recently engaged by the department of agricultural engineering at Montana State College to assist in the collection of data for two drainage projects near Bozeman, Mont.

HENRY L. RIVERSFILE, formerly with the Pennsylvania Railroad on construction of the new line from Indianapolis to Frankfort, Ind., has been made resident engineer in charge of street construction for Gilbert C. White, consulting engineer, of Durham, N. C. Mr. Riversfile is a graduate of Clemson College and for several years engaged in railroad and municipal engineering in Indiana and Ohio.

OSCAR A. D'LUHOSCH, formerly junior assistant engineer in the highway department of the State of New York, is now with the New York Public Service Commission in a similar capacity. At present he is located in Brooklyn on tunnel inspection. Previous to his employment by the New York highway department Mr. D'Luhosch was with B. H. Brevoort, consulting engineer, of Poughkeepsie.

M. P. NORTHAM, office engineer of the Southern Railway at Washington and before that assistant division engineer of the New York division of the Baltimore & Ohio Railroad, has been appointed supervising engineer.

WARREN B. JAMES, assistant at the summer surveying camp of the University of Michigan, will in September assume his duties as assistant engineer on construction of lock 4 of the ship canal at Sault Ste. Marie, Mich.

GEERT BLAAUW is now employed as designing engineer for the Pyrites Company, Limited, of London, England. He is located at Wilmington, Del., where the company is building a new plant, which will be its second in the United States.

Obituary Notes

COL. W. P. CLOUGH, chairman of the board of directors of the Northern Pacific Railway, died Aug. 17 in New York City. Colonel Clough was a close associate of the late James J. Hill.

EDWARD CANFIELD, general superintendent of the New York, Ontario & Western Railway, died Aug. 18 at Middletown, Ohio. He had been employed by that railroad since 1882. After graduation from Hobart College he entered railway service in 1869 in the engineer corps of the Erie & Genesee Valley Railroad, resigning a year later to become division engineer of the Syracuse Northern Railroad, in which position he remained for two years. The year 1872 found him in a similar position with the Pennsylvania Petroleum Railroad, from which he resigned the following year to become assistant engineer for the Atlantic & Great Western Railway. Mr. Canfield left the employ of the Atlantic & Great Western to go to the Syracuse, Geneva & Corning Railway as division engineer, remaining in that road's employ until his appointment in 1879 as assistant engineer for the New York, Lake Erie & Western Railroad. His promotion as roadmaster followed soon, and in 1882 he went to the New York, Ontario & Western as division superintendent. He was made chief engineer in 1887 and general superintendent in 1895.

ERNEST F. TABOR, project manager for the U. S. Reclamation Service of the Flathead project, Montana, died Aug. 20. Mr. Tabor was born in 1866 and had been engaged in engineering work for the past thirty years. For the Reclamation Service he conducted important work in a number of Western states and had charge of the Flathead project practically from its inception, including the design and construction of irrigation works costing upward of $1,500,000.

Civil Service Examinations

United States—Examination Sept. 19 for mechanical draftsman in ordnance department; salary, $1,320. Another for assistant examiner in patent office, salary $1,500, will take place Sept. 13-15. Form 1312 should be filled in by applicants.

Examinations Previously Announced

Date		See Eng. Record
Sept. 2.	Chainman, sanitary-engineering draftsman and superintendent landscape construction, New York State	Aug. 19
Sept. 5.	Subinspector U. S. radio towers	Aug. 19
Sept. 6 and 7.	U. S. structural-steel draftsman	Aug. 19
Sept. 13.	Aid in Coast and Geodetic Survey	Aug. 5
Oct. 11.	U. S. junior civil engineer	Aug. 19